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CONTENTS.

An Asterisk (*) denotes an illustrated article.

EDITORIALS—
Death of Mr. George A. McIlhenny..... 577
An Advance Budget from the Boston Meeting..... 577
The Market for Gas Securities..... 578
Something about Paints, by Dr. A. W. Wilkinson..... 578
Notes on Asphalt Paving, by Mr. H. Tobey..... 579
Tar as Fuel, by Mr. T. Bower..... 581
The Atomic Weight of Oxygen..... 581
Naphtha and Its Explosibility..... 582
End of the Edison Lamp Litigation..... 583
Applications of Superheated Steam for Steam Engines..... 585
Something about the Plant of the Clinton (Mass.) Gas and Electric Light Works..... 586
ITEMS OF INTEREST FROM VARIOUS LOCALITIES..... 588
To Rebuild the Dover (Del.) Works—Betterments on the Pittsfield (Mass.) Plant—Change in Corporate Name Accepted by the Columbus (Ohio) Company—The Oakland (Cal.) Company's New Office Building—Suit against the Hot Springs (Ark.) Company—Death of Mr. Jno. McConnell—An Odd Announcement at San Jose, Cal.—Reorganization of the Excelsior Company, Benton Harbor, Mich.—Public Lighting, Chelsea, Mass.—Candle Power of Hartford (Conn.) Gas—Sale of the Rockville (Conn.) Company—Annual Meeting, Reading, Mass.—Cost of Arcs to Alameda, Cal.—Mr. H. Maguire's Task at Hickman, Ky.—Dispute Over an Oil Pipe Line—Hints from Richmond, Va.—Cheaper Gas for Elkton, Md.—Gas Matters at Des Moines, Ia.—Concessions Made by the Boston Company to Its Consumers—And Many Other Items.

DEATH OF MR. GEORGE A. McILHENNY.

It is with profound sorrow that we announce the death of Mr. George A. McIlhenny, President-Engineer of the Washington (D. C.) Gas Light Company. The sad event occurred on Sunday, October 16th, and was the sequel to an illness of many years' duration. Deceased was in his 57th year, and his connection with the Washington Company covered a period of something over 27 years. Owing to the difficulty concerning the quick compilation of an accurate and extended history of the life of deceased, which difficulty arises largely from the fact that the American Gas Light Association was in annual session last week, our record of his life and work is put over to the issue for October 31st.

[Special Editorial Correspondence, by Telegraph.]

AN ADVANCE BUDGET FROM THE BOSTON MEETING.

BOSTON, Mass., October 20, 1892.

Dear JOURNAL: The first day's proceedings at the Twentieth Annual Meeting of the American Gas Light Association were brought off conformably to the programme arranged, and the numbers followed one another very smoothly. To commence with, it was easily perceivable, judging from the indications around headquarters, and at Young's, on Tuesday evening, that the attendance would be fully up to the standard in average and representativeness, and the opening scene at Pierce Hall, which, in respect of all that was needful to make a desirable meeting room, answered admirably, albeit it was perhaps a trifle too far from the hotel quarters of the majority, confirmed the promise of a large assembly. Quite a number of the fair sex also reported for the occasion, which mention leads me to say that they were most cordially received and entertained by a ladies' reception committee, for whom no trouble seemed to be too great in ministering to the comfort and pleasure of their guests. The Association was fortunate in the weather conditions, which were all that the most exacting could hope for in the latitude of Boston at this time of year. The city itself never looked better, so the spirits of all were in consonance with the state of the barometer. The hotel accommodations were fairly ample, although the concentration of the delegates was not as marked in this instance as, for example, in New York last year. The President, Capt. W. Henry White, looked to the inch a member of the Old Guard, and it is needless to add that he kept the meeting well in hand. But, to give you the proceedings in something like the regular order. The round-up of the roll-call on the first day showed that 153 were on hand, and Secretary Slater (of whom I may say, if Captain White looked and acted the Captain, Slater, Jr., kept equal pace with him in his appearance and action as Lieutenant No. 1), accounted for the admission of 42 new members—and in the list was the name of Mr. Zollikoffer, of the Consolidated Company, of New York. The Council report having been disposed of, more or less to the satisfaction of all concerned, the Association listened in glum silence to the report of the Special Committee appointed last year on the matter of a separate and suitable representation of the gas industry at the World's Fair, but accepted the inevitable in a spirit of grim resignation. The Committee, however, have nothing to grieve over in the manner with which the sincerity of their action was received; for I doubt if ever a Committee of the Association secured or was awarded a heartier vote of thanks than that given in Boston yesterday. There can be no gainsaying the fact that the gas men of the country deeply feel the disadvantage the industry will be in at the coming Fair, but it seems to me they have reasoned out about where the blame belongs and feel that nothing is to be gained now by a policy of recrimination. The President's address was splendidly received, and the Captain evidently had on his thinking cap during the time it was in preparation. Few will soon forget the beautiful tribute that he paid to the worth of Mr. George A. McIlhenny, the announcement of whose death came to the delegates from the West and South as they were speeding on to the reunion of an Association which had largely resulted from the labors of the dead one; for he was one of the faithful few that assembled at the Knickerbocker Cottage, New York, on April 16th, 1873, when the American Association first came to life. He had been a steadfast supporter of its purpose and aim for all the years; had been active in the ranks until the most insidious and lingering of bodily ills—paralysis—which, failing to dull his bright mentality, prevented him from protracted travel. Those who are young and aggressive—some day they will be older and more amenable to ordinary conditions—may not remember vividly that boat ride on the Potomac River (Twelfth Annual Meeting, Oct., 1884), when the old and the young, grouped in a circle around the man whom we mourn to-day, welled forth the strains of Auld Lang Syne. The patient sufferer had not met before in council with his brethren for years, nor has he done

so since, but the Auld Lang Syne chorus rang in many an old ear yesterday that was within range of the Captain's voice.

Three papers were read yesterday, and the discussions, as a rule, though not spirited, were well sustained. As before remarked, Captain White kept the proceedings well in hand, and no time was wasted once the business was fairly under way. The officers chosen for the year were as follows:

President—Arthur E. Boardman, Macon, Ga.

Vice-Presidents—W. H. Pearson, Toronto, Canada; Walton Clark, Philadelphia, Pa.; A. W. Littleton, Quincy, Ills.

Secretary and Treasurer—A. B. Slater, Jr., Providence, R. I.

Council—E. G. Cowdery, Milwaukee, Wis.; John McElroy, Pittsburgh, Pa.; W. R. Beal, New York; H. B. Leach, Taunton, Mass.

There is no doubt that the general sentiment is the meeting so far has been most successful, and that this is so is in no small degree to be credited to the tact of the officers and to the splendid organization of the local committees of arrangements. I might remark that though the headquarters and the meeting room are not close together I have very seldom attended a convention where the average attendance at the business sessions was larger or more punctual. I will send something more either to-night or to-morrow morning. Possibly prudence would dictate that the budget be forwarded prior to 7 P.M., for the banquet at the Vendome promises to be quite an affair.—***

BOSTON, Mass., Friday, Oct. 21, 1892.

The second day's proceedings were not particularly eventful, which is sufficient evidence of the fact that everything went off smoothly. The paper list was completed satisfactorily, and the discussions were well-sustained. The Question-Box, too, was quite a feature of yesterday's sessions; in fact, I think that this portion of the regular order obtained more attention and yielded better results than was the case at any other meeting of the Association. I might also add that the "partly promised" paper (it was read on Wednesday) proved to be an offering by Mr. Bredel, and he treated his subject in the common-sense manner that characterizes his efforts in any direction. The visiting delegation, by special invitation, was not numerous, until the banquet hour arrived. The Gas Commission of Massachusetts was, of course, represented by Mr. Barker, who looks as if they used him well on the other side, during his stay there last summer. He further seemed to be in a brown study over those "concessions" recently promised by Mr. Addicks and his associates to the gas consumers of Boston. Another feature of the attendance on membership account was the appearance of Col. Armington, who, I am glad to say, looks well and feels well.

The discussion aroused by the naming of a place for the coming-of-age meeting of the Association was long and spirited, but the advocates of the World's Fair city finally carried the day. I hope for President Boardman's sake—the genial, bright, quick-witted Georgian is to be congratulated on his good recovery from the accident of some months ago—that the promises of the Chicago advocates, as to the housing and so on of the members during the tumultuous times of the Fair period, will be borne out. The banquet was a complete success. The bill of fare was well arranged and the service was all that could be desired. Capt. White was toastmaster, and under his guiding hand the proceedings that assisted digestion never flagged. Messrs. Boardman, Chollar, ex-Governor Littlefield, of Rhode Island, Dr. Amory and Fred. Persons, made wise and witty responses to the subjects assigned them; and others also contributed to the general flow of instruction and entertainment. The banquet terminated at a "seasonable hour," in proof whereof, at 10 A.M. to-day, I can say that perhaps 175 of the members and guests can be counted on to board the steamer Nantasket for the outing on the Bay to the "Island" and back—you will, of course, note that 10 A.M. is a right early hour for a round-up after a banquet. I think all are agreed that the meeting was an excellent one.—***

The Market for Gas Securities.

During the week city gas shares sturdily maintained the advance made the week previous; in fact, if anything, prices were higher, as the result of an increased demand. Consolidated closed Thursday last (Friday was a legal holiday) at 118½ bid, but during the day sales had been made at 118¼. Equitable kept steady at 160 to 165, and Mutual was reported at 143 bid. Standard was neglected, at 85 bid for the preferred. This security, and the common stock as well, look to be a purchase, for it is measurably certain that dividends on the preferred will be resumed in January. Brooklyn shares show no change. They are dull and strong. As usual Chicago led the out-of-town gas shares in activity, the closing prices on Thursday being 91¼–92. Baltimore Consolidated is at 60½ bid, and is a purchase. We note the following at auction: $5,000 Fulton-Municipal 6's, at 106½ and interest; $2,000 Williamsburgh 6's, at 108 and interest; $2,000 Nassau certificates, 5's, at 100¼ and interest.

[A Paper read before the Society of Gas Lighting.]

Something about Paints.

By DR. A. W. WILKINSON, of New York.

It is the custom with some Societies to oblige members to write papers on subjects that they know nothing of; they do this for self-protection, for it would never do to allow a crank with his hobby to ride roughshod over the heads of other members.

Believing this to be a good rule, I have concluded to write a paper on paints; and, before I have finished, I think I will be able to convince you that I know nothing of the subject.

Paints are used by all classes and conditions of people; the untutored savage, with his war paint, hoping to strike terror to his enemy; the courtesan, equally as well daubed, hoping to win admiration, if not love, are good illustrations of paints to adorn the person. The more civilized use paint for the protection and beautifying of their dwellings. Paints have been used from the earliest times. We see in Egyptian tombs paints that have withstood the corroding influence of time for 4,000 years, and are still as bright as though they were put on but yesterday. They used the same materials as we use, the only difference being they were pure.

Paints are made from the vegetable, mineral and animal kingdoms. The mineral paints are the most abundant and most lasting; the vegetable furnish the most brilliant colors, but are easily affected by exposure to light, hence fade. The beautiful colors from coal tar, although more used for dyeing (yet some are used for paints), are illustrations of this class, with the exception of carbon, which is sometimes classed with mineral, and at other times with vegetable; they all soon lose their color, no matter what care we use for their protection.

The animal kingdom furnishes us with a few quite permanent colors—the cochineal, a bug that feeds upon the cactus, when dried, giving the beautiful carmine, a color quite permanent and much used, will illustrate this class.

It is not sufficient that we have a fine powder for a pigment, it must have a power to cause an oxidizing influence on the oil, and the minerals possess this power in a greater degree than the vegetable or animal. But they differ among themselves. Lead unquestionably stands at the head of the list; its oxides and carbonates possess covering, and that peculiar oxidizing influence on the oil that causes it to change to a substance not unlike amber, exceeding all other pigments.

The pigment known as white lead is a mixture of the oxide. Hydrated oxide and carbonate of lead—they may be precipitated from the acetates or nitrates of lead; but the white lead made in this way is crystalline and never equals the white lead made by the Dutch process. As this process is somewhat peculiar and interesting, and gives a pigment far exceeding all other white lead in quality, although the chemical composition is the same, I will repeat it. Pure metallic lead is cast in grates, stars, gridirons, or other convenient forms that will fit well in stone pots, in the bottom of which a quantity of acetic acid is placed—it must not touch the lead. These pots are placed in a brick chamber and surrounded with tanbark, boards are placed on top, and another layer of pots; these are likewise surrounded with tanbark. In this way a mound of several hundred pots are piled up, the whole being covered with the tanbark.

The heat generated by the fermenting tanbark evaporates the acid, which attacks the lead, converting it to the acetate of lead; this is decomposed by the carbonic acid, the acetic acid going deeper, corroding more lead, and followed by the carbonic acid until the whole of the lead is converted, in the course of a few weeks, into a carbonate hydrated oxide and oxide. When the pots are removed, instead of metallic lead we have a white substance of the same form, but enlarged; these are washed, broken in small pieces, thoroughly dried and ground to a fine powder. Under the microscope not the slightest indication of a crystal can be seen; it is to this fact that the extraordinary covering power is due. A pigment so valuable offers great inducement for adulteration.

The sulphate of baryta, a beautiful white stone, when crushed and ground to a fine powder, is the substance most frequently used. It is very heavy and mixes well with the lead; but it is sand to sugar; it only benefits the mixture—10, 20, 45 or 50 per cent. escapes detection to the ordinary observer, so common is the adulteration. I am told it is difficult to buy a pound of pure white lead paint.

Red oxide of lead, another valuable pigment, is adulterated with brick dust and oxides of iron to such an extent that many of its valuable qualities are lost. Zinc, when burned in the air, gives a white oxide in a very fine amorphous powder called nihil album—philosopher's wool and flowers of zinc, by the old chemists. It makes a very white paint, rather poor in covering qualities, but possesses the good quality of not turning

black with sulphureted hydrogen as lead will do; hence it is often used where this gas is likely to be found. Even this pigment does not escape adulteration. Chalk, magnesia and clay are often mixed with it, to its great injury. Iron gives many oxides, and mixtures of oxides, used for pigments, perhaps more frequently of late years than any other metal.

Pure oxide of iron makes a very desirable paint, but if clay, silicate and other earths are allowed, the hardening qualities are greatly interfered with. It is the cheapest of all pigments, gives a great range of colors, and, if properly handled, gives very good results.

Copper paints, from the fact that they are poisonous to all forms of life, are extensively used for the painting of ships; the ferrocyanide, acetate and arsenite of copper are the ones most frequently used.

Mercury with sulphur gives the vermilion; the color depends upon the skill in manufacturing. When properly made it is a permanent and brilliant pigment. The Chinese excel in its manufacture. Chemical analysis fails to detect the slightest difference between that of the ordinary red and the brightest vermilion.

All the rare metals produce pigments of greater or less value.

Without going into details we have given sufficient to afford an idea of the characteristics of pigments. What I wish to call your attention to is that we use different oxides and salts of different metals. It does not follow because acetate of copper (verdigris) is a good pigment that the acetate of lead or zinc would be, or that the sulphide of lead would make a good pigment because the sulphide of mercury (vermilion) is. These things can only be known from experiment. Almost every powder has been tested and its value noted. The oils used in paints are known as drying oils. This is an unfortunate term, for it gives the impression that they dry up as water, leaving the pigment as a residue; but such is not the case, as the oil undergoes an oxidizing process in the presence of the pigment and air which completely changes its character. Flax seed furnishes the greatest quantity, although we get drying oils from hemp seed, poppy seed and from several other sources.

Oils are divided into three classes: Fixed oils, such as olive oil, lard oil, etc., have a greasy feeling and remain permanent even after a long exposure to the air. Drying oils, oils that absorb the oxygen and become hard like amber. Volatile oils, that readily evaporate without change. By chemical treatment some of the fixed oils may be made to take on drying properties, fish oil being the most commonly used. Along our coast great numbers of mossbunkers, or menhaden, are taken and the oil expressed. This, when clarified and oxidized with litharge, becomes in a measure drying oil, sufficiently so as to enable it being used to adulterate linseed oil.

Linseed oil is expressed from the ground flax seed. As this seed is raised only to a limited extent, the amount of oil does not equal the demand, and it is a problem that many chemists are working at, to make an oil that can be substituted for it. Cotton seed oil has been experimented with and offers some hope of success. Fixed oils never thoroughly dry, no matter how carefully they are prepared. They give the paint a spongy or soft feeling, and are much more affected by the atmosphere, readily mildew and soon wash off.

It has been found that if the ground flax seed be saturated with the prepared fish oil and the two oils expressed together they will mix much better, and a much larger per cent. of fish oil may be used, the flax seed seeming to give drying power, or in some way to change its chemical affinity.

For the purpose of varnish making and fine paints we must have pure linseed oil, but for ordinary painting manufacturers feel that an adulterated oil is good enough, and pure oil can only be had by special contract.

To simply mix the pigment with the oil is far from making a good paint; it should be thoroughly ground, and the more it is ground the better the paint.

We are indebted to John W. Masury for the discovery that, if the stones used in grinding paints were kept cool by a current of water surrounding them, he could grind the paint much finer and have much better paints. The trouble heretofore had been that if the grinding were continued long the paints become hot and ropy; in fact, they were spoiled.

Paint is a mortar, and, like all mortars, requires a rough surface for it to adhere to. It has no affinity for the surface upon which it is applied, and if that surface be smooth and polished we need not expect it to stick. Take, for instance, a freshly planed pine board—how difficult it is to keep it well painted; but if the surface be exposed to the damp air for a length of time the paint will stay much better. Some painters prefer that the wood be exposed a number of weeks before painting.

The bright surface of tin is difficult to paint, but let it be exposed to oxidizing influence of the air and a superficial oxide formed, then the paints hold well. Sheet iron forms one of the best surfaces for paint. It is not only rough, but there is a superficial oxide formed in its manufacture which materially helps the oil to oxidize. The surface should be thoroughly dry—the thinnest layer of water is fatal to good painting; but the most important of all, and one the most frequently neglected, is the temperature. Paints will only oxidize or harden or dry at a temperature of 70° F., or thereabout; higher than that, they become too fluid and run from the surface; lower, they remain sticky, and, after a time, they form a jelly-like mass very soluble in the ammonia of the air, and easily wash off.

As well might a farmer expect his seed to germinate at a less temperature than 70° as for a painter to expect his paints to harden to that extent that will resist the action of the air and moisture. Paints may be so prepared that they will harden at a less temperature, but is a forced process and makes but poor work.

The painting of gasholders is the most important of all painting; here we have an expensive piece of apparatus, made of thin iron and subjected to the most trying conditions, the cold and frost of winter, the heat and rains of summer, every day immersed in a water saturated with ammonia, and, not unfrequently, in an oil condensed from the gas (no matter whether we make coal or oil gas), a most excellent solvent for poor paint or paint badly put on, taking the oil out of the paint, as it will, leaving the pigment to be washed off by the next rains or immersion in the water of the tank.

Every manufacturer of paint is sure that he has a paint that will give perfect satisfaction; nine times in ten it is the poorest mixture that one could use. But it is useless to condemn without offering a better. What, then, will give the best results, or be most likely to protect this expensive and delicate apparatus from the corroding influence of air and water?

A paint formed of pure oxide of lead or iron, well ground in pure linseed oil and put upon the holder when perfectly dry, and at the temperture of 70°, is the best protection known to science to-day.

It may be difficult to get the oil, and require some shopping to get the oxide of lead or iron, and some trouble to get them properly ground, and hard to impress upon the painters the necessity of having the holder perfectly dry, and secure a day when the temperature is about 70°; but if all this be done, the satisfaction and durability will well pay for the trouble.

Notes on Asphalt Paving.

[Read by Mr. H. Tobey, before the North of England Gas Managers' Association.]

It is not my intention to make any research into the history of road making with coal tar as a cement to bind the materials together. The discovery of its usefulness in that direction was probably somewhat after the manner of the discovery of the lusciousness of roast pig, which Charles Lamb has related with such delightful literary skill. The original "gas man," and those passing in and about the gas works, must very early have noticed the binding and waterproofing effect produced upon the ground where any tar has been spilt. The first efforts to produce a tar pavement would probably be in the direction of spilling more tar over other portions of the road proposed to be improved. This way—like the burning down of houses to produce roast pig—was soon found to be extravagant and unscientific. Successive coatings of tar, and layers of sand or ashes, would no doubt produce a tough, elastic, and waterproof pavement of a very durable nature; but it would be tedious to make, and consume much time and material. The shorter and more convenient method is to prepare the materials, lay them in their intended position, and roll them down.

In the process of gas manufacture a large amount of *debris* is produced, which often gives trouble in removal, and is difficult to get rid of. Sometimes it is given away; at others, it is necessary to pay for its removal. I refer to the ashpan refuse, the clinkers, and the old retorts and firebricks. To it may be added the small refuse from the coke stack. These form materials admirably adapted for asphalt or tar paving. Should the coal in use be such as contains a large percentage of ash and clinker, it is astonishing the accumulation of refuse of this kind which takes place. In utilizing these materials for asphalting, such of them as are not already small enough in size must be reduced. I find it convenient to pass them through a crusher, consisting of an old bone mill, which breaks them down so that the largest pieces are less in size than walnuts. It is then sorted into sizes by screening; the larger or coarser portion being put aside for the bottom or foundation course, and that portion which will not pass through a ½-inch screen is reserved for the top or finishing course. In this manner, the refuse heap is entirely

kept down, and the only useless things requiring to be removed from the works are simply mud and dirt which contain no grit in them. The old retorts and firebricks, or rather brickbats, and the clinkers give hardness and durability to the material. If too much breeze exists in it, it is soft and easily crushed when traffic comes upon it. The finer particles of the ashes and clinkers which have come from the breaker, when tarred, form a mortar or cement which gets into the interstices of the larger pieces of material and unites them together. For ordinary footpaths and back yards and court yards, these materials, with the addition of some hard gravel or spar on the surface, are sufficient for all practical purposes. It is not suggested that cart roads can be made in this way, or that it will stand hammering or pounding on. For such hard work, stronger and harder materials are required; and they should be laid thicker than for ordinary footpaths.

The next part of the work is that of mixing and coating the materials with tar, and partly saturating them with it. This requires some care and judgment, as too little tar or too much produces unsatisfactory results. In the one case, the pavement very soon breaks up and kicks to pieces; in the other, it gets soft and runs, and in hot weather the tar works out on the surface and treads about. Makers of asphalt differ much in their mode of procedure. Some heat their tar, and others the solid materials; the object either way being to drive off the small quantity of ammoniacal liquor which is always held in suspension in the tar, and also some of the lighter oils; and furthermore to give such fluidity to the tar as will make it run freely and mix with, and be absorbed by, the materials to be tarred. There is some little advantage in heating the tar if it is done in closed vessels, as the vapors can then be condensed by passing them through a condensing worm or still, and the ammoniacal liquor and light oils can be collected. If the tar is thin, it is the more expedient to treat it in this way; the light oils being a salable product. If we proceed by the directions given in "Newbigging's Handbook," we shall heat both the tar and the materials. I do not, however, regard it as necessary to do both. There is no doubt the solid materials work better when dry; and care should be taken to keep them dry. There is always a quantity of small coke in ashpan clearings; and when heaped up, if a little fire be put in, it readily burns through the heap, and drives off all moisture.

Though dryness of the material is, in my opinion, desirable, it is not absolutely necessary. I have known very good asphalting to be made with materials which were decidedly damp—I might say, wet; the only difference between it and other asphalting being that it did not set quickly. In a paper read before the North of Ireland Association of Gas Managers, in 1888, by Mr. Featherstone, of Dundalk, it is laid down as a rule that the materials—cinders, stone riddlings, and gravel—should be first drenched with water, and regularly puddled; then the tar added, and thoroughly mixed into a slush, with the caution to heat neither "stuff" nor tar, and a final direction to add more water when laying it down. This method of proceeding is, you will see, entirely contrary to the generally received ideas of the way to make tar or asphalt pavement. I have not found it answer to prepare it in this way. How the tar can be made to adhere to the wet materials is not at all evident.

As to the quantity of tar to be used, no exact and unvarying rule can be given. The nature of the materials, and their fineness or coarseness, will make considerable difference. Materials such as breeze, oolitic limestone, chalk, etc., have a great absorbing power. The oolitic limestone gravel that is obtained in our neighborhood is quite unsuited for asphalting, on account of its absorbent properties. After treatment with tar, it soon becomes dry; the only apparent result of the application of the tar being that the gravel has put on a suit of mourning. On the other hand, hard, dense stone or gravel, such as whinstone, requires very little tar to cover and saturate it. With respect to the fineness or state of division, it will readily be conceived that the sum of the surfaces of any given quantity of material will be considerably larger when it is broken up into very small particles than when the particles are large in size. For instance, a cubic yard of solid rock will have less superficial area than when it is broken down into sand. Consequently, the fineness of material increases the surface to be covered with tar.

I find in practice that it takes about 40 gallons of tar to make a ton of the foundation asphalt prepared from the materials I have mentioned—viz., clinkers, ashpan refuse, and old firebrick refuse ground up together—and about 50 gallons of tar to make up a ton of the fine or top material. It is always desirable to have in the top material some hard stone or gravel, as it is upon the upper surface that the wear takes place.

In every locality, there is nearly always to be found some native rock, igneous or otherwise, which is suitable for the work; or artificial substances, such as the slag from ironworks, may be used if broken to a suitable size. The fine asphalt, prepared for the finishing course, when laid on the rougher material forming the foundation, falls into the interstices of it, and, in addition, makes a thin superficial top coat; and, if durable, hard wearing material is incorporated with it, the life of the pavement is very much prolonged. Where pavement is to be subject to extraordinarily hard wear, it should be made entirely of such durable materials; but my main object has been to turn to account, and use up, the materials at hand which I have found an encumbrance.

Having prepared the materials, the next labor is to place them in position. It is desirable to have a firm foundation to lay them on; but the nature of the foundation, and the amount of it, depends largely upon the purpose for which the asphalt paving is intended to be used. Where it is proposed to asphalt existing footpaths, which have been trodden down and made firm by past usage, and which are not intended to have heavier work upon them than the ordinary wheelbarrow, the materials may be placed directly on them without the formation of a foundation. I have known a tennis court laid with asphalt upon ground from which the turf only was removed, and on which the thickness of the asphalt was not more than 1¼ inches; and it stood remarkably well. It is often specified that asphalt shall be 3 inches thick; but this appears to me an unnecessary thickness. The asphalt on nearly all the yards and paths we lay does not exceed 2 inches in thickness. First the rougher material is laid down, levelled, and rolled; then the fine is put on, and a little gravel or some Derbyshire spar sprinkled over it; and this also well rolled. The fine gravel or spar assists the rolling, and prevents the material clinging to the roller. Care has to be taken to get a proper watershed so that the wet may run off to the gullies, and not remain to make puddles for unwary feet to splash into. Of the bottom or coarse material, it takes from 50 to 55 cwt. to cover 100 square yards; of the fine, about 30 cwt. for the same area; and of spar or fine gravel, about 4 cwt.

My experience is that the manufacture and laying down of asphalt paving by the Gas Company has been appreciated by the public; and there is a fairly constant demand for it through the summer months, beginning about March and going on to the early part of November. We would not wish the demand to be continued beyond that time, as, in the winter months, we do not want to be troubled with it. The price charged is 1s. per square yard within a radius of 2 miles of the works; and beyond that distance, an extra charge is made for cartage. The price does not include any levelling of ground or foundation work. The average sales during the past eight years have been $1,000 per annum; and the profit thereon, after paying for the tar, labor in preparation of materials and outlay for gravel, spar, etc., has been over 40 per cent. As a minor branch of the works, it possesses the advantages of disposing of about 20 per cent. of the tar we produce, of keeping the men in our employ together in place of putting them off in the summer season, and, as I said before, it meets a want among our customers.

This asphalt paving has points in its favor, of which the following are some: In the first place it is cheap; no other pavement is so cheap, be it bricks, concrete, or flags. It makes a firm, hard pavement, free from moss, weeds, and mud. It is especially a dry pavement—brick and flag pavements allow the damp to penetrate through from below, but that is not the case with asphalt pavement. If placed under cover, it is permanently dry; it is therefore admirably suited for ground floors, on which articles are stored which have to be kept dry. It is obnoxious to vermin—such as rats and mice; they avoid it, and will not make holes or runs in it. And, furthermore, it is antiseptic and deodorant. Noxious and offensive gases will not pass from the soil through it. The sanitary condition of yards, the soil of which has become impregnated with garbage and filthy soakage, is vastly improved by the adoption of this pavement. It is a great advance in tidiness and cleanliness, and consequently of godliness. It is easy to repair, and to make good if disturbed, and is durable and lasting if not neglected. It is most desirable and expedient that every other year it should be tarred over with a brush and sprinkled with sand, spar, or grit of some kind. Such a course of treatment has the same effect as the application of Madame Rachel's wonderful cosmetics to the face of the human species—it beautifies its appearance, renews its youth, and lengthens its life.

Now that village councils are to be the order of the day, and the problem of how to retain our laboring population in the villages and prevent their exodus to the towns has to be solved, how can the parish parliament do better than commence to mend their ways, and make the paths of rural life more smooth, pleasant, and attractive, and what cheaper and better method can they find to do that than by laying down asphalt footpaths. When they commence this much needed work, I think they will find most gas managers willing and ready to assist them.

Tar as Fuel.

[Read by Mr. T. Bower before the Meeting of the North of England Gas Managers' Association.]

Six years ago I had the privilege of reading before this Association a paper on "Tar as Fuel." At that time you will remember that tar, even at the low prices then ruling, was in many instances almost unsalable; and a desire to increase its market value caused it to be consumed by many in place of coke in the retort furnaces. That such consumption was wholly, or even partially, responsible for the higher prices since obtained for tar, I am not prepared to say; but we are all well aware that, soon after the introduction of tar firing (which provided a new outlet altogether for part of our tar), its value began to increase, and continued to do so until it reached a figure that made it no longer profitable to use it as fuel. This has continued up till quite recently; but there seems to be again coming upon us one of those periods of trade depression which not only very considerably reduce the price of gas companies' residual products, but tend to stagnate and paralyze the various trades throughout the country. This, therefore, seems to me to be an opportune time to again consider the subject of "Tar as Fuel."

You will remember that, about the time mentioned, several very able papers were read before other Associations, describing different methods of consuming the tar, and also giving its value as a fuel. Upon the method of burning I do not propose to say anything to-day, but rather to look at the matter from a purely commercial point of view. Will it pay, with tar at its present low value, to use it in place of coke for retort firing? To determine this it will be necessary for each one to carefully study his own circumstances and resources.

It will be within your recollection that, at the time named, tar was at such low prices that a suggestion was made by Mr. George Livesey that all gas companies and corporations should burn 30 per cent. of the tar they produced. I am, however, of opinion that a better method would be for each company and corporation to consider carefully the data which is within their reach—whether, at the prices now obtainable for tar, it might not be more profitable to burn it than coke (always, of course, making allowance for any probability of the extra coke thereby thrown upon the market reducing the value of that article); and should it be found to be an advantage, then I take it to be the duty of each one of us not to limit ourselves to 30 per cent., but to consume as much as possible of the total production, with a view to increasing the value of the portion left for sale.

Taking my own experience, I found that, after having worked some little time, the average quantity of tar used per ton of coal carbonized was about 30 gallons; or, in other words, 7½ gallons of tar are equal to 1 cwt. of coke. On this basis, I should not be at all surprised to find that, in many instances in this locality, it would be more economical to burn tar and sell the coke now used. But on this point each one of you will be best able to decide for himself, after comparing the relative value obtained for tar and coke.

I will, with your permission, now read, from the "Reports of Gas Associations," some of the statistics which I gathered six years ago; and, although now the prices may be somewhat altered, they may still serve to emphasize the point I desire to bring before you—viz., that while it may be profitable to some to consume tar as fuel, to others it may be both a loss and an inconvenience. As I remarked in 1886: "From particulars I have received from various gas works in our own immediate neighborhood (most of the managers of which are members of this Association), I find that, taking as the basis of calculation the results I have given as my own experience, there are many to whom it would be a considerable saving to consume the whole of their tar, and dispose of the coke now used in their furnaces. For instance, there are ten companies whose average yearly make of gas is each about 24 million cubic feet; the price realized for coke, 11s. 8d. per ton; and the price of tar, 5s. 3d. per 100 gallons. Now, all these companies could have disposed of 20 per cent. more coke without affecting their present prices. By the use of 150 gallons of tar, at a cost of 7s. 10½d., in place of 1 ton of coke, a margin of 3s. 9½d. per ton would be left. From this amount must, however be deducted the cost of supplying steam, and the pumping of tar to the cistern (which will necessarily vary very much according to the circumstances at each works), say 6½d. per ton, which would leave a net gain of 3s. 3d. per ton for the extra coke to be sold. There are ten other companies, whose yearly make of gas is each equal to about 300 million cubic feet; the average price of coke, 7s. 2d. per ton; and tar, 4s. 2d. per 100 gallons. The saving in these cases, after making allowance for the cost of steam, etc., would be equal to about 4½d. per ton. Eight of the works could have disposed of 20 per cent. more coke; one of them is doubtful; and the other could not have sold any more at the price now charged. On the other hand, there are ten works whose average yearly make is each equal to about 48 million cubic feet; the average price of coke, 5s. 7d. per ton; and tar sells at 8s. 2d. per 100 gallons. To burn tar in these cases would entail a loss of more than 6s. per ton for the extra coke they would have for sale; many now finding their coke a drug in the market, even at the present low prices. From this information it will be seen that there is much scope for tar to be used as fuel without affecting the existing value of coke. If the first ten works mentioned burned all their tar, and the second ten (say) 50 per cent., leaving the last ten to sell all they produced, the effect would be to limit the quantity to be disposed of to the tar distillers by the 30 works to something like 60 per cent. of their total production—a system which, if universally adopted, would surely tend to increase the value of this residual, and would be a boon to distillers, who, I understand, would be glad to see the market rid of some of its surplus tar."

The Atomic Weight of Oxygen.

Engineering having noted that in *Comptes Rendus* for August 8th last was given a report of a new determination of the atomic weight of the element oxygen, goes on to say that the work has been carried out in the Laboratory of Physical Research at the Sorbonne, by M. A. Leduc, who is also the author of several important papers which have been published by the Academy of Sciences, all dealing with similar problems. The paper on the Density of Nitrogen Gas, and the Composition of Atmospheric Air, August 4th, 1890, and that on the Hydridation of Copper at Certain Temperatures, July, 1891, are especially interesting. The paper now before us announces that the atomic weight of oxygen, which has long stood in our standard tables at 15.96, is really only 15.877. Amongst the very great number of previous carefully made experiments by Dulong, Berzelius, Dumas and Boussingault, Erdmann, Marchand and J. Thomsen, given in Wigglesworth Clarke's "Constants of Nature," the lowest atomic weight given for oxygen, even amongst the obviously abnormals, is 15.894, while the lowest of the means by different experimenters is 15.9607, and "in the general mean, the atomic weight of oxygen becomes 15.9633, with a probable error ± .0035."

There are many ways of determining the atomic weight of oxygen, and it is extremely interesting to observe that, however the question be put to Nature, the reply to it is, within the error of observation, always the same. The ± .0035 is only like 7s. on £1,596 sterling. The new determination makes out that there has been an over-statement to the extent of £8 12s. in the sum named. The importance of this announcement is therefore very great. Perhaps the most interesting of the verifications of the 15.96 is that obtained from the so-called ether pressure theory of thermodynamics, which theory shows that if the pressure temperatures and heat of evaporation of steam are substantially as these were determined by Regnault, the atomic weight of oxygen must be substantially 15.96. For every unit in the second decimal place departure from this number there must be, say, 2½ units of heat, Fahrenheit, contrary alteration in the heat of evaporation of water. The demand made by the new determination of the atomic weight of oxygen amounts to, in the evaporation of steam, say, 20 units of heat, a quantity considerably in excess of what can be accepted as existing as latent error in Regnault's work. We do not mean to suggest that this theory has established for itself a position to entitle it to have equal weight against the work of the Laboratory of Physical Research at the Sorbonne, but it is because this theory pronounces the new determination to be untenable that we have been led to examine it, and it is by such comparisons that any theory can alone be judged.

The method of experiment was to decompose a portion of the water of an alkaline solution by electrolysis, to receive the gases produced, in a glass globe, and to ascertain the weight of the globe and gas as filled at atmospheric pressure. The weight of the same globe filled under precisely similar conditions with normal atmospheric air, free from moisture, was also ascertained. These were tared on the dummy globe system, to get the weights of the gas and of the normal air *per se*. From this relative weight or density the proportions of hydrogen and oxygen are calculated, the specific densities of hydrogen, oxygen and air being known.

The density of oxygen and of hydrogen in the calculation are taken from a paper by the same author, in *Comptes Rendus*, July 27, 1891, in which he gives the following new determinations of density:

	Leduc.	Regnault.
Hydrogen	0.06947	0.069269
Oxygen	1.10506	1.105641
Nitrogen	0.97203	0.971373

The final digits in the numbers in this paper are not always the same. The difference is, however, always quite unimportant; it exists in the papers we are dealing with.

The quantity dealt with was less than in Regnault's experiments in the proportion of 23 to 100.

The weight of normal air which filled the globe was 2.9435 grammes, and the weight of the same volume of the gases produced by electrolysis was 1.21925 grammes; therefore the relative density of the latter was

$$1.21925 \div 2.9435 = 0.41423.$$

Let

x = the percentage of volume of hydrogen in the mixture,

then

$100-x$ = the percentage of volume of oxygen,

and

$$x \times 0.06947 + (100-x)\,1.10503 = 100 \times 0.41423,$$
$$\therefore x = 66.708, \text{ volume of hydrogen,}$$
$$100-x = 33.292, \quad \text{“} \quad \text{oxygen.}$$

Multiply each of these volumes by the respective density and we shall have the relative weights of one atom of oxygen against two atoms of hydrogen. Double this quotient will be the relative weight of one atom of oxygen to one atom of hydrogen, thus:

$$\frac{2 \times 33.292 \times 1.10503}{66.708 \times 0.06947} = 15.877,$$

the new molecular weight of oxygen.

When Regnault's densities are employed this becomes

$$(1.10563 - 0.06926)\,x = 110.563 - 41.423$$
$$\therefore x = 66.7136$$
$$100 - x = 33.2864$$
$$\frac{2 \times 33.2864 \times 1.10563}{66.7136 \times 0.06926} = 15.934,$$

the new molecular weight of oxygen with Regnault's densities, on M. Leduc's method.

We have, by using the generally accepted densities, done away with about two-thirds of the alteration.

The method of electrolysis in this experiment is open to objection; it is not a positive process. On the great area of surface of electrodes there is a varying amount of hydrogen gas occluded. It is assumed that after a certain preliminary running the action will be constant, and the electrodes in the same condition at the beginning and at the end of the actual experiment. This may be quite reliable, but it is not absolutely so. By attending to constancy of pressure one source of error has been avoided, but the electrical history of the electrodes may be also a modifying factor.

According to the kinetic theory the relative volumes of gases in equilibrium, as these mixed gases would be, is proportional to the number of molecules in each. This is the law of Avogadro. This is subject to a slight correction for the effect of the absolute volume of the molecules, but this will be so small, at the pressure and temperature under consideration, that it may be now disregarded.

The validity of this law is well established by the densities and molecular weights in use before these new determinations were made, as may be seen from the following comparisons of the densities relative to hydrogen:

Oxygen.....1.105641 ÷ 0.069269 = 15.9615
Nitrogen.....0.971373 ÷ 0.069269 = 14.0232

Now these numbers have been fixed by experiment quite independently of any consideration of atomic weights. The kinetic theory of gases shows that the densities ought to be as the molecular weights, which are in this case the doubles of the atomic weights. In Clarke's “Constants of Nature” the final means of the atomic weights of oxygen and nitrogen are given as 15.9633 and 14.0210, numbers substantially identical with the above relative densities. Throughout M. Leduc's experiments there seems to have been no consideration given to this law. So far as we are able to judge, the work of M. Leduc has been done with great care and keen perception, as in the detection of the formation of a hydride of copper affecting the results obtained in some former experiments. Accepting for the moment all his results as valid up to the last, the atomic weight of oxygen, we may test its validity by the law of Avogadro, and these results, using Leduc's ascertained densities:

Oxygen.....1.10506 ÷ 0.06947 = 15.907
Nitrogen.....0.97203 ÷ 0.06947 = 13.992

The mixed gas produced by the electrolysis of water must consist of hydrogen and oxygen in the proportions, by volume, of two-thirds and one third. The relative density of the mixed gas, according to the molecular weight volume law and Leduc's densities, ought therefore to be:

$$\tfrac{2}{3} \times 0.06947 + \tfrac{1}{3} \times 1.10506 = 0.414666,$$

but the experiment gave, instead, 0.41423.

The conclusion to be drawn from this examination is that these densities of the mixed gas, the oxygen and the hydrogen, are inconsistent.

Let us ascertain what densities for oxygen and hydrogen would be consistent with the 0.41423 density of mixed gas. Let x = oxygen density, h = density of hydrogen, and n = atomic weight of oxygen, hydrogen being unity.

$$\frac{x}{3} + \frac{2x}{3n} = 0.41423$$
$$\therefore \frac{n+2}{n} x = 1.24269$$

If $n = 15.96$ then $x = 1.10431$ and $h = 0.069192$.
If $n = 15.877$ “ $x = 1.10366$ “ $h = 0.069513$.

Between these two values must be the density of oxygen if the atomic weight be between the accepted 15.96 and M. Leduc's new value, 15.877. But M. Leduc, as well as Regnault, says that the density of oxygen exceeds 1.105; therefore the set of numbers given by M. Leduc are not congruent.

If the densities for oxygen, nitrogen, and hydrogen, now given by M. Leduc are correct, the atomic weights of oxygen and nitrogen would be as found above, 15.907 and 13.992. The incongruity of the numbers as a whole, and the great alteration they involve in the previously accepted standards, suggest that the new determinations are still very much open to question.

In the experiment we know that the number of molecules must be two of hydrogen to one of oxygen throughout the whole mixture. The relative volumes must therefore be, not as 66.708 to 33.292, or as 66.7136 to 33.2864, but as 2 to 1, or as 66.6 to 33.3.

We will now calculate on this basis what the relative density of the mixed gases ought to have been if Regnault's constants, the established constants, are correct. There would be two-thirds of the volume of density, 0.06926, and one-third of the density, 1.10563.

$\frac{2}{3} \times 0.06926$	=	0.046173
$\frac{1}{3} \times 1.10563$	=	0.368543
Density of mixed gases	=	0.41472
As weighed by M. Leduc	=	0.41423

In Regnault's experiments the globe for, say, 10 liters, weighed 1,285 grammes. The weight of the *ballon* used by M. Leduc is not given in any of the papers, at least we cannot find it. We will, therefore, take it to have been about the same in proportion to the size, which would be exactly 295 grammes; but to get a round number we will say that it was 300 grammes. We will now calculate that the gross weights ought to have been in the last experiment, with the density and atomic weight of oxygen, according to Regnault, and compare these with the weights ascertained by M. Leduc.

	Mixed Gas.	Air.
M. Leduc's weights + 300 for the *ballon*	301.21925	302.9435
To establish Regnault's constants	301.22035	302.9424
Difference	.00110	.0011

or an error of the proportion of 1 lb. upon 100 tons.

If we can believe that an error in this proportion may be latent in M. Leduc's gross weight readings there will be, from his last determination, nothing to alter in the atomic weight of oxygen, as given in “Constants of Nature,” 15.9633, or, as is established in Regnault's densities of oxygen and hydrogen, as these are generally stated:

$$1.10563 \div .06926 = 15.9643,$$

the atomic weight of oxygen.

From the density determinations in M. Leduc's former paper we have shown that the number 15.907 comes out for the atomic weight of oxygen. Even this is so far from 15.9633 that we hesitate to accept it as final.

When we consider that the density of the mixed gas obtained by the electrolysis of water ought to be .414726 with Regnault's densities, and .414666 with M. Leduc's new determinations, and that the difference between these in M. Leduc's experiment might amount to only about 1 lb. on 800 tons in the gross weights dealt with, we think the prospect of arriving at a reliable amended atomic weight on this plan is not encouraging.

Naphtha and Its Explosibility.

The following matter, which explains itself, is from the New York *News* of recent date:

Whether naphtha is explosive or not was the point at issue in a suit by the Board of Fire Commissioners against the Standard Gas Light Company, just tried before Civil Justice Lachman. Sections 456 and

457 of the Consolidation Act prohibit the storage of explosive substances, in the first place without proper fixtures and arrangements to secure safety; and in the second place, without a permit from the Fire Commissioners.

The Commissioners found that the Standard Gas Light Company had a lot of naphtha stored in its premises at 115th street and Pleasant avenue, without a permit. The Company, in defense, took the square ground that naphtha is not explosive. It admitted that it kept naphtha at the place named. It was conceded that the construction and arrangements for safe-guarding its naphtha were everything that could be desired; that there were none better in the city or anywhere; and the Commissioners made no objection on that score. The great question was, is naphtha explosive, or is it not?

The Commissioners had already asked the Corporation Council his opinion as to whether the storage of naphtha without a permit was contrary to law, and he replied to the effect that, as naphtha was explosive, the unlicensed storage of it certainly was illegal. But this, as counsel for the Company remarked, begged the question; it took for granted the very thing at issue—is naphtha explosive?

Robert B. Stewart has been for four or five years an inspector of oils in the Fire Department, his specific duty being, as he stated, the testing of oils to determine their explosive qualities. He had been to the premises of the Standard Gas Light Company, and found the naphtha there.

"What is naphtha?" he was asked.

"The first distillation of crude petroleum," was his reply; and he drew from his pocket a bottleful of the stuff. He had been for 20 years examining naphtha, he said, and he pronounced it explosive, with the qualification "when confined." He admitted that his knowledge of naphtha was not scientific, but derived from practical experience. In calling it explosive he expressed the popular notion regarding it.

"Water, if confined in a boiler, can be made to explode, can it not? And other substances also?"

"Yes, sir."

"Yet you would not call water an explosive, would you?"

"As a general thing, no, sir."

"If you confine naphtha in a boiler or tube, and heat it, will it explode?"

"Yes, sir; heat will do it."

If naphtha be allowed to stand open in a room, he said, it will evaporate; and if a match be applied near the surface, it will take fire. If the naphtha be confined, it will explode.

"If fire be applied to the vapor of naphtha that escapes into the air, will it explode?"

"It will. I nave never made the experiment; it is a dangerous one to make; but I have seen it done."

This was all the testimony offered for the Fire Department to prove naphtha explosive.

The Gas Company called Prof. Chandler, the eminent chemist to the School of Mines in Columbia College. The Professor said that under no circumstances can naphtha be called an explosive.

It happens that the statute expressly forbids "a product of petroleum" to be housed without safeguards and without a permit; and after that emphatic declaration of Prof. Chandler the counsel to the Fire Commissioners proceeded to see if he could not bring naphtha under the ban as a product of petroleum, if not as an explosive.

"Is not naphtha a product of petroleum?" he asked the Professor.

"It is not so much a product of petroleum as a fraction or part of petroleum," was the Professor's reply. "It is a constituent of petroleum, from which it is drawn by distillation. The term, product, as scientifically used, implies a result with some change. Naphtha," he repeated, "is not an explosive compound in any sense of the term."

"If naphtha be heated in a tank or other vessel, will it explode?"

"Absolutely impossible," replied the Professor. "Almost any liquid," he continued, "is liable, when confined and subjected to a change of temperature, to fracture or burst the containing vessel; as water will, either when frozen or sufficiently heated; but such fracture or bursting is never called an explosion. Such effect is not an explosion, but comes from expansion of the liquid. As to the popular notion about naphtha being explosive, every combustible substance when combined with something else may be said to be explosive. The something else that does the work is commonly oxygen. Charcoal would never be called an explosive substance; yet if charcoal be given sufficient oxygen, it will become a so called explosive. So will sugar, starch and many other substances. Gunpowder may be made by combining any of these with something capable of supplying enough oxygen. Gunpowder is ordinarily made of charcoal, sulphur and saltpeter, fully one-half of the last-named element being oxygen. But there are kinds of gunpowder having other combustibles instead of charcoal in them, allied with oxygen. Starch, wheat flour, even sawdust, may be made to produce varieties of gunpowder. Hence the explosions that sometimes occur in flour mills, cotton gins, candy factories, and other places.

"If naphtha is converted into vapor and mixed with a certain quantity of air—neither too much nor too little—an explosive substance will result." The Professor said he visited the Gas Company's storage premises in 115th street, and found the naphtha so protected that an explosion was impossible. As he understood, there is no gas for illuminating purposes now sold in New York that is not prepared from naphtha.

The counsel to the Fire Department took him in hand and asked him to define an explosive compound. His definition was, "a compound that is liable to explode when brought in contact with a spark or by percussion. Gunpowder," he said, "is harmless so long as it is not brought in contact with fire in some form; and the same is the case with naphtha."

"But when naphtha or naphtha vapor is brought in contact with fire, an explosion will follow, will it not?"

"Not necessarily; only when the vapor of naphtha is properly mixed with air, not too much or not too little, as I have said. Naphtha is only a combustible substance, a substance that will burn when something else gives it oxygen, but has in its own essence nothing explosive. It is not like nitrogen, which is explosive *per se*, and does not have to be mixed with anything."

"What is an explosion?" the Professor was asked. After thinking a good while, he replied that he had not looked in the dictionary, but should hazard the definition that an explosion is "a sudden expansion with considerable violence." An explosion, after all, is nothing but a rapid combustion. The Court of Appeals, he believed, had decided that gunpowder does not explode.

The fact is, said the Professor, with the advance of science, the old nomenclature has been found not to answer. The term "explosion" may be said to have exploded for modern uses. It is too vague, and for modern requirements two new words have come into fashion, "deflagration" and "detonation." The former is used for a substance that needs oxygen to help it burn rapidly; the latter for a substance that burns rapidly of itself. Gunpowder deflagrates, nitro-glycerine detonates. It is only its rapid burning with the help of oxygen that entitles gunpowder to be called explosive; and, after all, gunpowder is not so very rapid an agent. "A man can walk," said the Professor, "a great deal faster than gunpowder explodes."

After some remarks by the lawyers and a promise by them to send briefs within a week, they consented that Judge Lachman might take his own time to decide the case. The Judge said he would decide it within 20 days after he got the briefs. So that altogether on the great question whether naphtha is explosive or not, a judicial decision may be expected inside of a month.

End of the Edison Lamp Litigation.

The *Western Electrician*, in its report respecting the decision of the celebrated incandescent electric lamp ownership case in the United States Circuit Court of Appeals, says:

The litigation over the incandescent lamp has been ended in a victory for Mr. Edison, whose patents are sustained. On Oct. 4 Judges Lacombe and Shipman, of the United States Circuit Court of Appeals, handed down a decision in the case of the Edison Electric Light Company against the United States Electric Lighting Company. The suit was originally brought on three patents, No. 223,898, dated Jan. 27, 1880; No. 227,229, dated May 4, 1880; No. 265,777, dated Oct. 10, 1882. Before trial, however, the original bill was amended, the plaintiff withdrawing the last two patents. The cause was tried before Judge Wallace, of the Circuit Court, Southern District of New York, and his decision, which was handed down July 14, 1891, was published in the *Western Electrician* of July 25, 1891. Judge Wallace granted an injunction restraining the United States Electric Lighting Company from manufacturing or using incandescent lamps, and at the same time ordered an accounting for damages and profits on lamps already made by that Company. The case was appealed. The present decision sustains that of Judge Wallace. The following abstracts from the opinion, which was written by Judge Lacombe, cover the points involved in the controversy:

The patent sets forth that "the object of the invention is to produce electric lamps giving light by incandescence, which lamps shall have high resistance so as to allow of the practical subdivision of the electric light." By the phrase "subdivision of the electric light" is meant such

a subdivision of the electric current that at several alternating foci supplied from the same source of electricity there shall be developed lights of moderate intensity—comparable to those given out by our ordinary gas jets—and the problem to be solved required a system and apparatus which would admit of the development of these moderate lights in sufficient number and at so low a cost as to be commercially useful.

Prior to 1879 experimenters seemed to have reached the conclusion that success was to be obtained, if at all, by modifications of the arc lamp; but up to that time no lamp, arc or incandescent, had been given to the public which, with the means then existing for generating and distributing the electric current, accomplished this result. Since the date of the patent in suit electric lighting by lights of moderate intensity has become a commercial success. Subsequent improvements in the lamps and in other parts of the system have undoubtedly contributed materially to its development, but the record abundantly shows that with lamps such as the patent describes, constructed with the skill then known to the art, and operated under the conditions admitted by the generating and conducting apparatus then existing, it became practical for one generator to operate a considerable number of lamps located at reasonable distances from it, and which at the same time were economical, durable, and cheap enough to be commercially useful, and so simple and reliable that they could be manipulated by the public. In view of the utter failure of the prior art to produce any such subdivision of the electric light, a lamp of this kind, which was capable of economical use in factories, large buildings, and in smaller buildings contiguous to each other—in other words, available for isolated lighting—should be considered commercially successful, though further development were needed to enable it to compete with gas for domestic lighting, on even approximately equal terms.

It is not necessary to enter into any elaborate discussion of the prior state of the art so far as it bears upon the question of patentable novelty of such embodiment of a number of high resistances and small radiating surface. Irrespective of all patents or publications of others, the philosophy of this method of producing light is undoubtedly found stated clearly and sufficiently, and applied to the production of an incandescent platinum burner in Edison's French Patent No. 130,910, taken out May 28, 1879. Whether under Section 4,887 of the Revised Statutes that patent, embodying as it does his own invention, is or is not sufficient, so far as Edison is concerned, a part of the prior art and to what extent in view of the prior art, that patent discloses patentable invention need not be determined upon this appeal, inasmuch as we are satisfied that there was invention in the substitution of the carbon of the patent in suit for the platinum of the French patent, even though all knowledge as to what should be the ratio of resistance to radiating surface were pointed out, either in the French patent or elsewhere in the art.

In his invention, as described in the French patent, Edison departed from the existing idea of burners of low resistance; declaring the commercial and scientific necessity of burners of high resistance, although they must be slender and presumably fragile, and attempted to find a method of protecting them from the effects of heat and of the atmosphere. It is said that the heretofore known laws of electricity should have taught every one that an electrical incandescent lamp must have a burner of small cross section and small radiating surface. The electrical laws had been known and had been recognized, but they did not tell how to protect the materials which would make efficient burners from the destructive effect of other sources than electricity to which they must be subjected; in other words, they did not tell how to construct a lamp. Edison, in his French specification, followed the principle of high resistance to an extreme, made platinum burners with a resistance of 200 to 300 ohms, and described the method by which they were to be prevented from speedy deterioration "by destroying or intercepting the atmospheric action." He freed them from occluded gases by subjecting them to a high degree of electrical heat in a vacuum, and subsequently sealed them also in a vacuum. The platinum lamp, however, did not achieve success. Inasmuch as carbon has a specific resistance from 200 to 400 times that of platinum (hard, dense carbon having a lower resistance than porous carbon), is practically infusible, had been long before suggested as a translating device and used as such in many of the lamps devised by the prior art, it might be supposed that when one skilled in that art was seeking a substitute for the platinum wire, something which would by reason of high resistance and small radiating surface apply the philosophy disclosed in the French patent, and yet admit of operation at higher temperature without melting, he would have turned to carbon, but the record in this case clearly established the converse of this proposition. Carbon, when exposed to the air at a temperature sufficient to produce incandescence, undergoes combustion. To remedy this difficulty, earlier inventors suggested inclosing the carbon burner in a glass globe, from which air and moisture were to be excluded. Their globes were separable, to allow of replacement of the interior parts. We do not find in the words "suitably sealed," used in the King patent (British, 1845, No. 10,919) to describe a modification of his lamp for use under water, sufficient warrant for the contention that its structure was to be so radically changed as to substitute a light and compact all-glass globe with irremovable burner for the cumbrous apparatus with its column of mercury, which he describes in detail.

Neither the inclosing chamber of Crookes, nor the Geissler tubes—though being all of glass, with wires sealed in, they would not leak—were used by the prior art to protect incandescent burners. By reason, in part, of that mode of construction with a separable chamber, the vacua which the earlier experimenters sought to secure could not be maintained. Though subsequent improvements in exhaust pumps might give their apparatus a higher initial vacuum, it would rapidly disappear in the leaking globe. It was against the oxygen or other carbon consuming gases that all prior inventors sought to protect the burner, and later inventors tried to accomplish the result by filling the chamber with nitrogen or some other gas which was inert, *i. e.*, did not combine with the carbon; the carbons themselves were also subjected to processes for making them harder and more tenacious, and series of carbons were arranged to be brought in operation successively without opening the chamber, but one and all of these devices failed to secure stability in the carbon. A deterioration variously described as a "disintegration," "a wearing away," "a kind of evaporation," was soon fatal to the life of the burner. The record abundantly established the proposition that so far from turning to carbon for his first burner, which was to have so high a ratio of resistance to radiating surface, one skilled in the art would have been led by the teachings of that art to suppose that its instability would prove fatal to its use, irrespective of the size of the burner. Especially is it true that the use of small carbons in the attenuated or filamentary form which Edison had indicated in the platinum patent would not have been thought of. Nor do we find in the suggestions of Lane-Fox, either in his patents (British, Nos. 3,988, 4,043, 4,626, of 1878; 112, of 1879) or his other publications, any such appreciation of the cause of the disintegration of carbon or any such proposed method of preventing it as would controvert the conclusion that the art was looking elsewhere than to carbon for the burner which should have a future. Certainly Lane-Fox himself seems to have looked for success rather to his metallic alloys and his compounds operated in nitrogen or other suitable gases than to carbon in a perfect vacuum. The literature of the art fully sustains the statement of Mr. Schwendler quoted in the *Telegraphic Journal* in 1879 that "we can scarcely expect that the principle of incandescence will be made use for practical illumination," unless there be discovered a conductor without the defects of platinum, and "which does not combine at high temperature with oxygen."

In June, 1878, and January, 1879 (United States patents 205,144 and 211,262), Sawyer and Man indicated one of the causes which operated to produce this disintegration of the carbon—viz., that "some oxygen or other element or compounds remained in the lamp," the carbon "occluding sufficient air or oxygen to render its consumption a mere question of time," as "the least quantity of oxygen in a sealed lamp is sufficient to combust an indefinite quantity of carbon."

This they sought to remedy by heating the carbon pencils immersed in a hydrocarbon liquid to an extremely high temperature, thus producing a hard and dense carbon (and one whose specific resistance was lowered by that very process). They also, while the globe was on the pump and nitrogen flowing in and out of it, heated the "carbon to incandescence, thus driving out all the impurities and occluded gases which are carried out of the lamp by the current of nitrogen." Believing that the deterioration of the carbon burner was due to the presence of occluded oxygen, which escaped into the sealed chamber and "promoted combustion," they sought to secure stability by substituting for the oxygen they had forced out by heating on the pump an atmosphere of nitrogen; that done they sealed their chamber, which seems to have been a separable one.

Edison had experimented with carbon before he devised the platinum lamp of his French patent. Subsequently to the date of that patent, apparently because that lamp did not seem to promise the success he hoped for, he again turned to carbon. In the course of his investigations he made a discovery as to the cause of "disintegration," of which he availed himself to devise a lamp, in which carbon, even in the filamentary form required for a burner, whose ratio of resistance to radiating surface was such as to apply the philosophy pointed out in his French patent, could be maintained for a sufficient length of time to become a commercial success.

At the date of the application for the French patent he had appar-

ently reached only the point that "pencils (not filaments)" "of carbon can also be freed from air in this manner and be brought to such a temperature that the carbon becomes pasty, and if it is then allowed to cool, it is very homogeneous and hard." The knowledge that practical stability can be given to a carbon filament was not gained until October, 1879.

Edison's invention was practically made when he ascertained the heretofore unknown fact that carbon would stand a high temperature, even when very attenuated, if operated in a high vacuum, without the phenomenon of disintegration. This fact he utilized by the means which he has described, a lamp having a filamentary carbon burner in a nearly perfect vacuum. Although all glass globes with leading wires passing through the glass and sealed into it had been used before to preserve the condition of the interior of a chamber from the effects of leakage at the joints, and although the prior art, including the French patent, indicated that subdivision of the electric light was to be obtained by the use of burners of high resistance and small radiating surface; and although pencils of carbon had been tried in imperfect vacua—and found wanting—it was invention, in view of the teachings of the art as to the disintegration of carbon under the action of an electric current, to still select that substance as a suitable material from which to construct a burner, much more attenuated than had ever been used before—reduced in size to the filamentary form, in which economy of construction requires that it must be used in order to avail of the philosophy of high resistance and small radiating surface—and so to combine old elements, that the disintegration due to "air washing" should be practically eliminated, and the burner thus become commercially stable. It is true that carbon burners still break down; that the improvements, neither of Edison nor other inventors, have made them absolutely stable, and in a sense it may be said that Edison only made them more stable than they were before—that it is a mere matter of degree. But the degree of difference between carbons that lasted an hour and carbons that lasted hundreds of hours seems to have been precisely the difference between failure and success, and the combination which first achieved the result "long desired, sometimes sought, and never before attained," is a patentable invention.

It is also true that the combination and manipulation, which secured a practically perfect vacuum by heating the burner, while the exhaust pump was at work, and subsequently sealing the globe without introducing a foreign gas, is set out by Edison in his French patent as the means of effecting such a change in the condition of platinum as would permit its being raised to higher temperatures, without rupture, cracking or diminution of weight, by volatilization. But the evidence shows that the platinum lamp did not achieve success, and we think there was manifest invention in the substitution of carbon, freed from occluded gases, and placed in the nearly perfect vacuum. The change of material involved a reorganization of the lamp, dispensing with the thermal regulator, which was an essential part of the structure of the French patent; it developed new properties in the lamp by reason of the enormous differences between the resistance and the melting points of the two materials; it utilized the discovery of that cause ("air washing") of the instability of carbon, which seemed to preclude all hope of its future usefulness as an incandescent illuminant; finally and principally, by the substitution there was presented the complete combination of elements, which for the first time in the art produced a practical electric light. We are of the opinion that on principle and under the authorities such a substitution of material is invention.

The second claim of the patent is broad enough in its phraseology to cover the invention above set forth—at least when the burner is a carbon filament. This last word is not specifically defined in the patent, though therein it appears for the first time in the art. It was a common English word with a meaning sufficiently plain to indicate that the cross section of any article which it was used to qualify must be so small as to be threadlike, and we think a sufficient indication of what that size is would be afforded by an examination of the ordinary threads in common use.

An examination of the patent, however, indicates its dimensions with more exactness. It is to be fragile, so small in cross section that, compared with earlier carbon rods, its use is a "reversal of former practice." One of the substances suggested in the patent to be used as a burner is to be reduced to .007 of an inch in diameter. Ordinary cotton thread, also suggested in the patent, has varying diameters, the largest commonly used being $\frac{1}{4}$ of an inch in diameter; the Patent Office model has a diameter of about $\frac{1}{16}$ of an inch. The evidence fails to satisfy us that the prior art furnished any burners less than twice this size.

The second claim may be thus paraphrased:

The combination of carbon, filamentary or thread-like in size and properly carbonized, used as an illuminant in an incandescent electric lamp, with a receiver made entirely of glass and conductors passing through the glass, and from which receivers the air has been exhausted to such an extent that disintegration of the carbon, due to the air washing action of surrounding gases or to any other cause, is so far reduced as to leave the carbon practically stable.

Defendant's lamps are plainly infringements of the second claim as thus construed.

Defendant further contends that the patent is invalid, because it does not so describe the lamps as to enable a person skilled in the art at the date of the patent to make a practically useful structure. The evidence of the witness Howell seems to us a conclusive answer to this contention. He made, as he testified, according to the directions of the patent, and using only processes known to the art before its date, incandescent lamps, such as the patent describes, which lasted 600 hours. Defendant criticises this evidence, because the witness subjected the filaments made by him to the action of the electric current during the process of exhaustion. But the patent repeatedly directs that the vacuum shall be high and nearly perfect. Sawyer and Man had, prior to the date of the patent, shown that there were occluded in the carbon itself, and in the various internal parts of lamp chambers, gases and impurities, which are set free by the passage of the current. Manifestly, if they were not removed before sealing, the nearly perfect vacuum would soon disappear. Edison's French patent also details a process for forcing them out of platinum and removing them while exhausting is going on, and a person who was sufficiently skilled in the art to know of these earlier publications, and was carefully solicitous to conform to the directions of the patent, would naturally have resorted, as Howell did, to this method to secure a vacuum free, so far as might be, from the intrusion of such occluded gases. It is contended, however, that this process of "electric heating on the pumps" in effect produces a carbonization of the filament, that it is now used as a part of the process of carbonization, and that, therefore, because the patent simply directs that the filaments be "properly carbonized," because electrical heating is now used with the understood object of supplementing the work of the carbonizing furnace, because Edison has always thus heated his filaments, and because such additional carbonization is necessary to make a practical lamp under his patent; therefore, he has either purposely suppressed an essential element of his process, or has failed to give the full, clear and exact description of it which the statute calls for. To this proposition we cannot consent. It is immaterial that the philosophy of electric heating on the pumps is better understood to day than it was in 1879, so long as the requirements of the patent would not be complied with by one skilled in the art, unless he did in fact so heat the filaments. Whether he heated to carbonize or to secure a nearly perfect vacuum, the result would be the same—an operative lamp produced by following the directions of the patent with the ordinary skill of the art, and that is all the patentee was required to show.

Other points interposed by the defendant, based upon legal technicalities, are passed over briefly by the Court, which finds in them nothing applicable to the cause under consideration. The decision is based squarely on the question of the invention of the first practical incandescent lamp, and as such is a notable victory for Mr. Edison.

Applications of Superheated Steam for Steam Engines.

A paper contributed some time ago to the English Institute of Civil Engineers gives an account of a series of steam engine experiments made in 1891 with and without superheated steam, with the view of ascertaining the actual economy of fuel and steam realized by superheating. With one exception the trials were carried out upon Woolf beam engines. One object was to determine whether, by the use of superheated steam, sufficiently favorable results could be obtained from old and uneconomical steam motors to justify their retention, instead of discarding them for modern engines. Unfortunately, the author and his coadjutors were only able to test two kinds of superheating apparatus. Other methods were either not reduced to practical working conditions, or, like the Schwoerer system, the experiments made upon them were not ready for publication. In this paper the results of eight sets of experiments are given, preceded by a short account of the method adopted of superheating the steam.

Gehre Superheater.—In this system, as at present used, the steam is not heated by a separate apparatus, but the superheating pipes are placed in the flues of the boiler. This method of superheating the steam has been extensively adopted. It is simple, requires no separate stoker, and can be easily introduced into existing flues. One apparatus is often used to heat the steam from two boilers. Where the boilers are at a distance from the engines and long steam pipes are required

the Gehre system has been found insufficient. The inventor is now endeavoring to remedy these defects, and to adapt his method to other working conditions.

A series of experiments extending over six days were carried out with the Gehre superheater. The economy obtained by the use of superheated steam was calculated in quantities of coal pure and dry (deducting moisture, ash and clinker), and care was taken to make all the trials under ordinary working conditions. Four boilers were in use, and a Green feed-water heater. There were three sets of superheaters, and the hot gases passed once only under the boiler, and then through the flues on their way to the economizer. The steam was used by a couple of Woolf beam engines with variable expansion, and was superheated 100° F. The trials were in pairs on two successive days with and without superheating, and each trial lasted about 10¼ hours. The mean pressure of steam was 5.5 atmospheres. In the original paper tables of results of the experiments are given in full detail, both for the boilers and the engines. The economy due to the use of superheated steam was 11.2 per cent. of steam per hour per indicated horse power, and 8.7 per cent. of coal, pure and dry, per indicated horse power per hour. The gain per cent. was less than might have been expected, and lower than in the later trials. The defective utilization of the heat is attributed by the author to the insufficient surface of the superheater, which was too small for the size of the boilers. The same engine had been tested a few years previously with ordinary steam. With five boilers instead of four in use, practically the same results for horse power and consumption of coal were obtained, showing that with superheating four boilers would do the work, whereas five were required with ordinary steam.

Uhler Superheater.—This is the first of his new appliances at work in or near Mulhausen for superheating the steam with a separate fire. It resembles a field boiler. The ordinary steam passes from the boilers into a series of small vertical pipes, set inside larger tubes, and heated directly from a separate furnace. The steam is thus dried and superheated as it rises through a number of these tubes into a collector, and from thence it is led in well covered pipes to the steam engines. This method of superheating was not found entirely successful at first, but improvements have been made, and it has now but one main defect—namely, the sedimentary deposit is sometimes formed at the bottom of the large tubes. Superheating being principally applied to high-pressure boilers, the steam contains and carries along with it a certain quantity of water, and it is liable to deposit the impurities in this water at the lower end of the tubes over the fire. If pure water be used, the tubes are kept clean and there is no danger of their becoming clogged. The distance from the fire to the bottom of the tube is 8 feet.

Four experiments on successive days—March 3, 4, 5 and 6—were made on the Uhler superheater. The economy obtained by superheating is given in steam per indicated horse power per hour. Three boilers were used with a Green feed-water heater. The superheated steam passed directly, without entering the jackets, to the valve-chests of two Woolf beam engines, both of the same dimensions. On the first two days experiments were made with ordinary steam. The mean pressure of the steam was 5 atmospheres, and it was superheated 133° F. The experiments lasted about 10¼ hours, or one working day. The economy in steam due to superheating was found to be 22.4 per cent., and the number of revolutions and the indicated horse power were also greater than when working with ordinary steam. The loss by radiation was small in these trials.

In the next two experiments, made in March, 1891, with and without superheated steam, the economy realized by the application of superheating was 30 per cent. in consumption of steam, and 27 per cent. in coal pure and dry. The steam was superheated 120° F., and the mean pressure was 4.7 atmospheres. The engines tested were about 30 years old, and were shortly to be replaced by new. The next two experiments, made under the same conditions, showed a slight leakage in the feed-water pipe, which affected the accuracy of the results, although the trials gave a coal economy, due to superheating, of 22 per cent.

During April and May four experiments were made on the same engines as before. Each trial consisted of an experiment one day without, and the next day with superheated steam. In all the superheating tests the steam passed directly to the valve chests without entering the cylinder jackets, and the work was done with one boiler less with ordinary steam. The experiments in April gave 19.32 per cent. economy of steam, and 25.6 per cent. economy in coal due to superheating the steam 135° F., and the pressure of the steam was 5.2 atmospheres. In the May experiments two boilers were used instead of three with ordinary steam. With steam at a pressure of 7.3 atmospheres, and superheated 93° F., the steam economy was 23 per cent., and coal economy 23.4 per cent. The superheater was some distance from the boilers, and this diminished the temperature of the steam, although the pipes were fairly well covered. Experiments carried out on June 25 and 26 did not yield such favorable results. The economy obtained by the use of steam at a pressure of 6.4 atmospheres, and superheated 115°, was 20.6 per cent. of steam and 17.8 per cent. of coal; but the power was unequally divided between the two cylinders, and other working conditions were not as favorable as before.

The last series of experiments were made on two successive days in August, 1891, under the same conditions, on a Woolf beam engine. The superheater was nearer the engine and boiler than on any previous occasion. Three boilers were used when the steam was superheated, but with ordinary steam four were found necessary to develop the power. The results were more favorable than in the previous experiments. An economy of 27.2 per cent. of steam superheated 118° was realized, and 25 per cent. in coal. The steam pressure was 5 atmospheres.

From the complete details of all the tests given in the original paper, of which the above figures are only a very brief summary, the author draws the following conclusions:—Taking the mean of the seven experiments made with the Uhler superheater, the increase in the boiler efficiency was 5.2 per cent., and the quantity of coal burnt per hour per unit of heating surface was diminished 11 per cent. with superheated steam. With this steam 2.07 per cent. less in quantity was produced per hour per unit of heating surface for same work done with the same number of boilers as under the ordinary conditions. By the use of superheated steam, therefore, one boiler in four can be dispensed with; the fuel was also better utilized, and the boilers kept in better condition, because a smaller quantity of coal was burnt and less steam evaporated per hour per unit of heating surface. It was found, and this is an important practical result of these interesting tests, that no surface damage or scoring is caused to the valves, pistons, or cylinders of the engines by the use of superheated steam, if metallic packings are employed for the stuffing boxes and the cylinders lubricated with oil of the best quality. The effect of steam jackets was diminished and was even found detrimental. In all the engines experimented upon steam was used in the jackets only to heat the cylinders before starting, and shut off as the engines were running. These experiments also prove that the less difference between the temperature of the cylinder walls and of the entering steam the less condensation there will be during admission, and the smaller the gain by superheating. The tests do not throw much light on the question of steam pipe loss. In some trials the loss by radiation was about 1° F. per 3¼ feet, and in others much more; but it is absolutely necessary in all cases to protect the pipes with the utmost care, and the superheater should also be carefully covered to prevent radiation.

The author concludes by stating, as his opinion, that the use of superheated steam, as exemplified in practice for the last year or two in Alsace, gives practically satisfactory results, and can be safely recommended. A considerable economy may always be realized, but the extent of saving will depend on the construction of the engines and the rate at which the boilers are worked.

Something About the Plant of the Clinton (Mass.) Gas and Electric Light Works.

In the number for September, *Electrical Progress* makes the following mention of the works of the Clinton Gas and Electric Light Company:

The Clinton Gas Light Company began the manufacture and supply of gas in 1854, before there was an electric telegraph cable across the Atlantic, and even before kerosene oil was thought of. In fact this plant, almost 40 years old, stands to day as a fitting example of business enterprise at a time when the manufactures of New England were in an embryotic state. Located slightly off the line between Boston and New York, Clinton has not attracted such diverse manufacturing industries as have Worcester, Springfield, and Fitchburg, which are on the main thoroughfare of railroad development, but the growth of Clinton is rather all its own and due entirely to the business energy and ability of its citizens. In 1886, the Schuyler electric light plant, operating arcs only, was acquired by the Gas Company. The Thomson-Houston incandescent system was at once introduced, by the installation of a 650 light alternator, and business, especially mill work, very soon increased so rapidly that the old station was found insufficient to supply existing demands, and an addition or a new station became a necessity, it being finally agreed upon to abandon the old station and erect a new one, which was built about two years ago. The building of the new station was decided upon with the view of embodying in a building the

most advanced ideas of central station construction, and the matter was given into the hands of the Wright Electrical Engineering Company, of Boston. The building is one story high, of brick, with a mill construction plank roof. The engine room, between the boiler room and the electrical machinery, opens without a partition into the dynamo room, so that an unobstructed view can be had of the engines, switchboard, and dynamos. There are two 45-light Schuyler arc machines and three 650-light alternators, and one 1,000 light alternator of Thomson-Houston make. They are operating to-day 60 arcs and 3,000 incandescents, and the increase from mill lighting will undoubtedly shortly double the plant. The station is so designed that the increase can be made without changing the present plant.

The celebrated Bigelow Company Mills and the Clinton Wire Cloth Company are lighted from this station. In fact, the cordial co-operation of the mills and electric light station in Clinton is unique in the history of electric lighting. All too prevalent among mill men is the idea that central station prices are too high, and among electric light men that mill lighting at prices the mill owners cannot afford to refuse is an unprofitable branch of central station business. The profitable and satisfactory management of the Clinton station proves the contrary.

The motive power consists of a 75-horse power low-speed Fitchburg engine, connected with one end of the jackshaft by a Hill clutch, and used for light loads; and one-half of a 500-horse power compound condensing slow-speed Fitchburg engine, belted to a 6 foot driving pulley on a quill shaft, a large Hill clutch being used to throw the load on and off this engine. The change over from one engine to another is simple, and a matter of a few minutes. The large engine is brought to speed, the clutch thrown in and the little clutch thrown out immediately after, taking the small engine out of service without a flicker in the lights.

The Evans driving system is in use in the station. As is well known, this system is a combination consisting of two pulleys, surrounded by four belts, bearing equally against the driving pulley, and it is claimed that it is consequently capable of transmitting twice the power of a single friction pulley with loose belts.

The switchboard is entirely of slate, after plans by the Wright Company, and a new section has recently been added. A valuable feature of this board is an ample space in the rear as well lighted as any part of the station, where connections are made as easily as in a workshop. Nearby is a special switchboard for the Bernstein series lamps, of which there are two circuits of 44 lamps, of 25-candle power, for street lighting, and when we say 25 candle power, that amount actually and not nominally is meant. It has ever been the policy of the management to give full measure, and the successful carrying out of this policy has not resulted in a single complaint regarding brilliancy or candle power, and the feeling of unrest among many towns in regard to municipal or private ownership is entirely absent from Clinton.

The boiler room has space for five boilers, two of which, built by the Robinson Boiler Works, of East Boston, Mass., of 125 horse power each, working at a pressure of 90 lbs, are already installed. The plant is run non-condensing, as an ample supply of water flows constantly by the station, although a condenser is installed and ready for use when advisable. The boiler room covers a separate floor space, but it is on a lower level. There is a Wainwright heater, a Dean condenser and a Korting injector, the latter being used as a reserve, the city pressure of 120 lbs. feeding the boilers direct. The chimney stack is 90 feet high, also built by the Robinson Company, 5 feet in diameter, suitable for 1,000 horse power, and calculated to stand without guys, although these have been added in deference to safety. The wire in the station is okonite on porcelain insulators.

The gas plant has for a background a bit of a view of the town. The works are fitted for coal gas, purified by oxide of iron, made on the premises; and there is an excellent demand for tar and coke. Notwithstanding the growth of electric lighting, the output of gas increases steadily, and since Mr. Spaulding's superintendence began the street mains and works have been brought to a high state of efficiency. The policy of the Clinton Gas Light Company is one of business—no undue expansion or inflation. The directors look upon gas and electric lighting as a legitimate and permanent investment for capital; and that they have succeeded is shown by the Company's excellent financial standing, the continuance of which is assured by the satisfaction of the users of gas and electricity. The points in which this station differs from many others of the same size are in a convenient and well-designed station, a thoroughly built system of conductors, an efficient superintendence, and liberal business management. The value of the electric plant in six years has grown to double that of the gas plant, nearly 40 years old, and it is hard to say which is the better investment.

Mr. Henry N. Bigelow, Treasurer and General Manager of the Company, is a business man through and through. His father was the founder of the famous Bigelow Carpet Company, of Clinton, and he was practically, it may be said, brought up with that industry. He was in turn its Superintendent, Agent, and Manager, through which positions he performed faithful and valuable service, jeopardizing even somewhat his health. He was prompted to connect himself with the Clinton Gas Light Company, about ten years ago, because of his family and personal interests therein, assuming the position he still holds, and of course carried with him, and inaugurated into the business conduct of the Company, the same practices of business details and methods which he had observed with the Bigelow Carpet Company, which told so much to their benefit; and he has obtained similar results for the Gas Company. There is nothing that escapes his attention, so thorough a master is he of detail work.

Mr. Bigelow manages this gas and electric plant on a purely commercial basis, is as firm a believer as ever in gas manufacture, and does not hesitate to assert that electric lighting has operated in its favor rather than against it, the brilliancy of the electric light creating a demand for increased candle power and consumption of gas. He has been and is still a close student of the electrical business, as well as an earnest and constant inquirer into economic measures and principles affecting the conduct of the business from a central station point of view, and many of his ideas, owing to this study, are embraced in the new station of his Company. In short, he is in the business for business purposes and advantages, and most always obtains profitable results. Mr. Bigelow is in the prime of life, has a happy family and the pleasantest of home surroundings.

Mr. William H. Spaulding, the Superintendent of the Company, is a young man, and has already accomplished much to his credit in gas and electric lighting. He really belongs to a gas family. His father is a veteran in the gas business, being at present connected with the Waltham Gas Light Company, while he has a brother holding a prominent position with the Brookline Gas Company. Mr. Spaulding, even while pursuing his studies at school, assisted his father in his work, and before his 21st year accepted a position with the Keene (N. H.) Gas Light Company. It was while with this Company, in the installation of its electric light plant, that he gained his first knowledge of the electrical business, and he virtually installed this electric plant without any previous practical experience in this direction. He remained with the Keene Company for three years, and in 1888 resigned his position therefrom to connect himself with the Clinton Gas Light Company, where he has remained ever since. Mr. Spaulding terms himself "a man of all work," asks no one to do what he will not do himself, and has the fullest confidence of Mr. Bigelow. He is popular with everyone who knows him.

Mr. Charles H. Herrick, Consulting Engineer of the Company, has occupied that position ever since it adopted incandescent lighting, and earned it through the valuable services he rendered in the construction of the station as Manager and Engineer of the Wright Electrical Engineering Company. It was he who drew the plans of the station and all its details, including pole lines, switchboards, etc., the construction of which he also superintended, as well as the station and store wiring. Mr. Herrick is also young in years, and has acquired for himself an enviable electrical reputation. He received his training at the Massachusetts Institute of Technology. His first connection was with the Western Electric Company, of New York, returning to Boston, where he was engaged upon motor designs for quite a period, later entering the service of the Thomson-Houston Electric Company as one of its corps of engineers in the installation of plants, and finally in 1888 accepting a position with the Wright Electrical Engineering Company, of which he is, as has been stated, Manager and Engineer, and the Clinton station is only one out of ten large central stations designed by him and erected under his supervision. He is an earnest, persistent, and conscientious worker, pleasant and agreeable always, and it is these facts that have contributed to his success.

In concluding our tribute to the Clinton Gas and Electric Light Works, its magnificent pole line construction is worthy of special mention. The pole line consists of heavy chestnut poles, extra heavy cross arms which are braced to the poles, special break and fastenings designed by the Wright Company, and Russell mast arms for suspending arc lamps, together with Cutler brackets for street incandescent service. The conductors which carry the current are of the American Circular Loom Company's "Canvas Jacket" insulation. The substantial character of the pole line construction has been proved by the fact that since the station has been in operation not a single wire has broken, although the line has been exposed to severe wind, snow and sleet storms incident to our New England climate.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

THE United Gas Improvement Company has arranged with the proprietors of the Dover (Del.) Gas Light Company for the remodeling of their works. A complete Lowe water gas plant, including a scrubber and auxiliary machinery, is contracted for. The plans also call for a new purifying plant. Messrs. W. F. Johnson & Brother, of Milford, who lately acquired an interest in the Dover property, together with President A. B. Richardson, whom we are more than pleased to note will remain active in the control of the Company, have wisely decided to put the works upon a thoroughly safe operating basis, and we make no doubt the people of Milford will not be slow to appreciate the fact. The city street lighting contract has just been renewed.

WE are indebted to a correspondent for the following respecting improvements on the plant of the Pittsfield (Mass.) Company: "The Pittsfield Coal Gas Company has about completed extensive improvements in its plant. Four new purifying boxes have been put in, and the new purifying plant has quadruple the capacity of that which it replaced. A station meter, rated to pass 250,000 cubic feet per 24 hours, has also been installed. Other plant betterments are a new exhauster, with Huntoon governor, and a 10-inch center seal. In fact, the meter and purifying rooms have been practically rebuilt and refitted. The Company now has the capacity of making 150,000 feet of water gas and about 100,000 cubic feet of coal gas in 24 hours, and is fully equipped for all the demands that can be made upon it for years to come. At present the Company is supplying a 23 candle mixed gas, using Lima crude oil, but it has been determined to change to naphtha. The Sewer Commissioners have given the Company permission to connect its drains with the old East street city sewer line, which is not now connected with the general house sewerage system of Pittsfield, so that hereafter all odor arising from the drainage into the river in front of the gas works will be avoided. The works are to be surrounded by a high board fence, and a general repainting is in progress. The entire expenditure will be about $10,000. The Company has never paid very much for 'nickel plate' trimmings, but it has kept pace with the best means of gas making and means to furnish, as it does, gas of excellent quality, standing among the very first in that respect in the State, at a reasonable price. Instead of increasing its capital stock, it has paid out in two years for improvements $35,000 without making any addition to its capital stock for the consumers to pay profits in the way of dividends upon."

THE stockholders' meeting of the Columbus (Ohio) Gas Light and Coke Company, for the purpose of passing upon the resolution of the Directors, under which the property and franchises of the old Company were to be vested in the Columbus Gas Company, was held and the transfer was formally ratified. It is, as was explained before in our pages, a reorganization without material public significance.

AN Oakland (Cal.) correspondent, writing under date of the 14th inst., forwards the following: "The cornerstone of the building being erected by the Oakland Gas Light and Heat Company was laid a few days ago. This is to be one of the first corporation buildings erected in the city, and will be a model of architecture when completed. The first story is to be of ornate granite, with an imposing entrance on Thirteenth street. The second story is of pressed brick and terra cotta, all of a novel style of art, and differing from any of the buildings in the city. The interior finish will be of a tasteful and artistic design, and the entire structure will be of California manufacture. The main contracts have been awarded to Oakland artisans. The ceremony of laying the stone was performed by the President of the Company, Mr. Jas. G. Eastland, assisted by his sons, Jos. L. and Thos. B., the latter two acting as Masters of Ceremonies. T. B. Eastland made a well-timed address. In the box that was placed in the cornerstone were deposited coins of the year 1892, copies of the local papers, lists of officers of the corporation and copies of office bills and records. The edifice will be completed and ready for occupancy about March 1, 1893, and it will reflect credit on the corporation building it. The cost of the structure will approximate $40,000, and will open upon Clay street, a new business quarter, which, with Washington street, promises soon to become a rival of Broadway. The Oakland Gas Light and Heat Company, always recognizing the improvement and advancement of the city, has set an example worthy of emulation by other local corporations."

EDWARD HARDIN, of Hot Springs, Ark., has brought suit against the Garland Gas Light Company of that place for $10,000 damages. Complainant, who was a fireman in the engine room of the city hall, alleges that he was reduced to an unconscious condition through having inhaled gas that escaped from a defective pipe into the basement of the city hall. He asserts that the permanent result of such inhalation has been a "shattered bodily condition."

MR. JOHN MCCONNELL, for several years an Inspector in the service of the Philadelphia gas works, died about a fortnight ago.

THE San Jose (Cal.) Light and Power Company, being moved thereto by the belief that some evil disposed parties have tampered with its gas mains, has caused the publication of the following advertisement in the local papers: "The San Jose Light and Power Company will pay $500 reward for the arrest and conviction of any person found pumping air into or tampering or interfering with the mains, pipes, services or meters of this Company."

MESSRS. C. M. EDICK, J. S. Morton and J. E. Stevens, Jr., have purchased the entire holdings of Mr. Peter English in the Excelsior Gas Company, of Benton Harbor, Mich. The Company will be reorganized.

THE Chelsea (Mass.) Gas Light Company has offered to the city a renewal of the contract for public lighting, based on the following terms: Arc lamps to be furnished for $90 per light per annum, incandescents (24-candle power) to be paid for at the rate of $15 each per annum. The lighting table calls for 300 nights' illumination in the year, from dusk to daylight.

DURING the month, according to the report of the city gas inspector, the illuminating power of the gas supplied by the Hartford City (Conn.) Gas Light Company, averaged 21.4-candle power.

MR. HANNIBAL H. CHURCH, who has been in the service of the Lawrence (Mass.) Gas Company for many years, has resigned his position.

A HINT from Steubenville, O., rather goes to show that the Royal (natural) Gas Company is in trouble over its sources of supply, in that many of the manufactories have been notified that no gas service can be maintained "in the daytime."

MR. EDWARD M. TUCKE has been elected to the vacancy in the Board of Directors of the Lowell (Mass.) Gas Company occasioned by the death of Mr. James B. Francis.

THE proprietors of the Riverside (Cal.) Gas and Electric Light Company have determined to overhaul their street main system.

THE New Haven Gas Company is laying a new main to ensure a better gas supply to the outlying district of Fair Haven.

WE understand that arrangements have been perfected, chiefly through the agency of Mr. H. L. James, whereby certain Bridgeport (Conn.) capitalists have secured control of the franchises of the Rockville (Conn.) Gas and Electric Light Company.

AT the annual meeting of the Citizens' Gas Light Company, of Reading and Wakefield, Mass., no change was made in the Board of Directors. The executive management announced by the Directors is appended: President, Mr. E. H. Capen, of Tufts College; Treasurer, Mr. J. H. Buck; Secretary, Mr. L. R. Wallis.

THE gas plant of the Pintsch system, which is to be operated in the Union Pacific Railroad Company's yards, Kansas City, Mo., will be completed before November 15th.

THE people of Alameda, Cal., have no very great reason to congratulate themselves on their cleverness in installing an electric lighting plant to be operated on municipal account. They have been trying the thing for some time now, and are obliged to confess that the results are very far out of line with economy. Arcs, to the number of 88, are maintained from the plant, and the cost of running the same for the past quarter, excluding all charges on account of rental of premises and depreciation, averaged at the rate of 7.3 cents per lamp per lighting hour, actual.

MR. HENRY MAGUIRE, formerly Superintendent of the Belleville (Ills.) Gas Light and Coke Company, is now engaged in carrying out for the contractor (Mr. John R. Truesdell) the construction of electric lighting and water supply plants for the city of Hickman, Ky. The electric lighting installation calls for one 45 light dynamo, lamps to be of 2,000-candle power; one 300-light incandescent dynamo, lights to be of 16 candle power; and 5 miles of wire. The water plant contract calls for buildings, boilers, engines, pumps, and 4 miles of main pipe. The electric plant will be placed in the water works buildings, and one steam plant will operate both services. The estimated cost is $35,000.

THE Pennsylvania Railroad Company and the Crescent Oil Company have been engaged for some time, according to the *Petroleum Reporter*, in a bitter contest at Marietta, Lancaster county, Pa., over

the refusal of the Railroad Company to permit the oil pipe line to pass under its tracks. For several days the Railroad Company had two repair trains and a hundred men guarding the scene, and as fast as the workmen of the Pipe Line Company did any work the Railroad people undid it. As a last resort the Pipe Line Company procured an injunction from the courts, restraining the Railroad Company from any further interference. This, together with the obstacles put in the new line by the farmers, has hampered the Company considerably, and retarded the completion of this line at least a month or six weeks. It was confidently expected to have the pipes laid to the termination at Marcus Hook (or Linwood), located in Delaware county, Pa., in Lower Chichester township, at a point on the Delaware river some 18 miles southwest of Philadelphia), where the buildings are completed and awaiting the oil supply, but existing circumstances have made it impossible that the final point will be reached prior to Nov. 10.

As was indicated in our last, the Commmittee on Light of the Richmond (Va.) City Councils submitted a majority report to the Board of Aldermen, recommending that no auxiliary water gas plant be installed on the city gas works. Mr. Gunn, from the Committee, submitted a minority report favoring such installation, and put the probable cost thereof at $25,000. Mr. Gunn also submitted a report (unanimous) from the Committee on Light, favoring the appropriation of $125,000 for the establishment of a city electric lighting plant. All the matters were referred to the Finance Committee.

THE proprietors of the Elkton (Md.) Gas Light Works have decided to reduce the gas rate for all purposes in that city to $2 per 1,000, a reduction on gas used for illumination of 50 cents per 1,000. Gas for fuel purposes has been sold there for some time at $2 per 1,000. When the present proprietors of the Elkton works assumed control (1881) the all-round rate was $4 per 1,000.

A CORRESPONDENT at St. Louis, Mo., forwards the following: "Two applications for gas franchises are before the City Council of Des Moines, Ia., one of which was presented by Mr. Samuel Compton, of Compton & De Forest, of Des Moines, who are evidently acting for speculators located in Topeka, Kas, and the other came through Messrs. Read & Read, of Des Moines, who assert that local capital is concerned in their application. The Topeka concern's preamble recites that the name of its corporation is the Johnson Fuel Gas and Construction Company, that it has a plant in operation at Topeka, Kas., and that it wants a 20-year franchise to do business in Des Moines. The first section of the document states that the Company desires to construct an extensive plant to manufacture fuel and illuminating gas from petroleum 'by a new process,' and asks for authority to lay conduits and mains in the streets, provided the manner in which said conduits is carried out is not to interfere with the drainage of the city, nor to damage the water mains. Section 2 deals with the routine to be observed in the matter of opening the streets and restoring the same. Section 3 avers that the price of gas to the city for public buildings shall be, during the 20 years, not in excess of $1 per 1,000 cubic feet, and that street lamps are to be supplied with gas at the rate of $1 per post per month. The price to private consumers is to be $1.15 per 1,000, with 15 cents per 1,000 discount on all bills paid at the Company's office within 15 days from presentation of such bills. Section 4 asserts that the Company will equip the public lamps with 4 feet burners, and that the burning hours are to be from one-half hour after sunset, and one hour before moonset, to one hour before sunrise and one-half hour before moonrise. This section also binds the city to take gas from the Company for 20 years for buildings and street lighting—there is also a proviso that it shall not interfere with the present electric lighting system; but when street gas lamps are ordered by the city, such lamps shall be used and paid for for a term not less than 5 years. Section 5 sets forth that mains will be extended for street lighting purposes at the cost of the city, but such city mains are not to be tapped by the Company for the supply of ordinary consumers until the Company has repaid the city the cost of such laying. Section 6 brings out that the privilege or license granted is upon condition that the Company shall at all times provide gas and extend its mains so as to accommodate the entire city, at the rate of 50 feet for each consumer requiring the extension. Section 7 directs that the Company shall, during the first 10 days of January in each year, report to the Council the number of consumers, and the monthly consumption of gas for the preceding year. Section 8 specifies that the gas shall be of not less than 16 candle power, and that it shall be of good quality. Section 10 provides that the Company must sign the ordinance 30 days after its passage. The other proposition (that handed in by Messrs. Read & Read) is as follows: To the Mayor and City Council of the City of Des Moines—The undersigned respectfully petition your Honorable Body to grant to the National Light and Fuel Company, a corporation hereafter to be organized by them, a charter and licenses to maintain and operate in the city of Des Moines, gas works for the purpose of supplying gas at a gross rate of $1.50 per 1,000 cubic feet, with a discount of 25 cents per 1,000 cubic feet for payment within a period limited and specified, with such proper provisions and conditions as will be mutually acceptable. The paper bore date of October 7, and was signed by Messrs. F. A. Percival, W. W. Lyons, Chas. L. Gilcrist, M. M. Crookshank and Read & Read. Both propositions were referred to the proper committee for consideration and report."

IN the meantime, the ordinance under which it is proposed to cut the selling rate of the Capital City Gas Company, of Des Moines, to $1.35 per 1,000—the substitute offered some weeks ago, or shortly after the decision of Judge Conrad to the effect that the $1.25 ordinance was an unjust one to the Company—hangs fire. Should the present ordinance under consideration be adopted there is no doubt the Company will contest it in the courts on a plea similar to that which formed the basis of the successful protest.

ELLENSBURGH, Wash., has been lighted (?) by an electric lighting plant operated by local parties, under leasehold from the authorities. The service, however, was so inadequate that the people finally forced the local rulers to declare the lease forfeited, and now the Solons are trying it again on municipal account.

THE Monarch Electric Lighting Company has offered to furnish the town of Moscow, Idaho, with 40 arcs (2,000-candle power each) at the rate of $10 per arc per month, on a moontable.

THE creditors of A. Shaw, of Nanaimo, B. C., advertise that they will, on the afternoon of the 29th inst., sell at public auction, to the highest bidder, the local electric lighting plant. Mr. Shaw freely admits that he is unable to keep the concern going.

MR. W. E. BROWN, Business Manager of the Vancouver (B. C.) Electric Light Company, has notified the local authorities that as the incandescent electric lamps in the City Hall and Fire Hall have not been used in accordance with the terms of the contract, he will insist on the placing of meters in each building.

THE Holyoke (Mass.) gas plant has been overhauled, and the retort house improvements will enable the Company to increase its sendout something like 25 per cent. Last summer four miles of street mains were added to the distributing system.

THE following from the Boston *Herald* of the 14th inst., was forwarded by "C. H. D.": "Pleasant news it will be for every one in Boston to learn that the price of gas will go down after January 1, 1893, that the candle power of the light will go up, and that gas will be supplied for cooking purposes, if desired, through separate meters. All this was practically decided yesterday before the State Board of Gas and Electric Light Commissioners, at the hearing in Beacon street. The hearing was on the petition of citizens of Boston to reduce the price of gas to consumers. Long delays there have been—the hearings have been postponed again and again, but Messrs. R. M. Morse and Moody Merrill, counsel for the petitioners, together with Mr. H. M. Cross, have persistently and tenaciously held to the demands of the petitioners, and their efforts in that direction have been successful. Before the Commissioners, yesterday morning, appeared the counsel for the petitioners, and Messrs. A. B. Coffin and C. P. Greenough, counsel for the Boston Gas Company. Mr. Merrill, said early in July he believed the corporation would accede to the request without further hearing. Mr. Merrill had made a proposition, and was ready to submit it. He had looked into the matter very carefully, fully keeping the wishes of the petitioners in sight. Mr. Merrill, in the long run, believed that the petitioners would get more than they asked. He read the propositions, as follows: First—That on and after January 1, 1893, the candle power be increased from 16 to 25. This stipulation is made because if the Company reduced the price it might also reduce the candle power. Second that 25 candle power gas be supplied by the Company, for cooking, heating and power purposes at $1 per 1,000 feet, to be supplied through separate meters, to be furnished free by the Company. Third—That all who burn $1,000 worth of gas per annum for illuminating purposes shall receive a monthly discount of 10 cents a 1,000 feet. Messrs. Coffin and Greenough asked for a few hours' time to present their case to the Company, promising to give an answer in the afternoon. The morning hearing was then adjourned to 3 P. M., at which time the hearing was reopened. Mr. A. B. Coffin, speaking for the Company, said: 'Counsel for the Company have consulted with some of the officers, and we feel authorized to say that the Company will give assent to the requests made by the petitioners, represented by Mr. Moody Merrill and Mr. R. M. Morse. In regard to the time when the candle power shall be raised to 25, that may take place by January 1st, but any delay will be because of the time required to arrange and regulate the required machinery. The Company is willing to furnish gas for cooking purposes through separate meters, and will give a discount of 10 cents per 1,000 feet to consumers who use $1,000 worth or more of illuminating gas per year.' These concessions Mr. Coffin hoped would meet the approval of the Board. Mr. Merrill had confidence in the Gas Company's promises, but he thought there should be some binding recognition of the agreement, for he (Merrill) had known of cases where large corporations had failed to carry out the agreements made. Mr. Merrill hoped the Gas Commissioners might make some order by which the petitioners could force the Company to stand by its promises. The Commissioners recorded the promises, and the citizens may feel sure of the petition being granted."

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AGENTS.

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Advertisers Index.

GAS ENGINEERS. Page

Jos. R. Thomas, New York City ... 609
Wm. Henry White, New York City ... 607
Fred. Bredel, New York City ... 603
H. C. Slaney, New York City ... 609
Frederic Egner & Co., St. Louis, Mo ... 600

CHEMISTS.

Durand Woodman, New York City ... 609

PROCESSES.

National Gas Light and Fuel Co., Chicago, Ills ... 598
Bartlett, Hayward & Co., Baltimore, Md ... 605
United Gas Improvement Co, Phila, Pa ... 597
Burdett Loomis, Hartford, Conn ... 607
National Gas and Water Co., Chicago, Ills ... 599

GAS WORKS APPARATUS AND CONSTRUCTION.

James R. Floyd & Sons, New York City ... 607
Continental Iron Works, Brooklyn, N. Y ... 592
Delly & Fowler, Phila., Pa ... 607
Kerr Murray Mfg. Co., Fort Wayne, Ind ... 604
Stacey Mfg. Co., Cincinnati, Ohio ... 607
Bartlett, Hayward & Co., Baltimore, Md ... 605
Morris, Tasker & Co., Limited, Phila., Pa ... 605
Davis & Farnum Mfg. Co., Waltham, Mass ... 604
R. D. Wood & Co., Phila., Pa ... 606
Bouton Foundry Co., Chicago, Ills ... 607
Isbell-Porter Company, New York City ... 603
Fred. Bredel, New York City ... 603
United Gas Improvement Co., Phila., Pa ... 597
National Gas Light and Fuel Co., Chicago, Ills ... 598
Berlin Iron Bridge Company East Berlin, Conn ... 594
National Gas and Water Co., Chicago, Ills ... 599
The Gas Works Construction Co., New York City ... 591
Frederic Egner & Co., St. Louis, Mo ... 600

GAS AND WATER PIPES.

Meilert Foundry and Machine Co., Reading, Pa. (John Fox, Selling Agent, N. Y.) ... 601
Ohio Pipe Co., Columbus, Ohio ... 601
M. J. Drummond, New York City ... 601
R. D. Wood & Co., Phila., Pa ... 606
Warren Foundry & Machine Co., New York City ... 601
Donaldson Iron Co., Emaus, Pa ... 601
Addyston Pipe and Steel Co., Cincinnati, O ... 601
Detroit Pipe and Foundry Co., Detroit, Mich ... 601

ELEVATORS, CONVEYORS, ETC.

Link-Belt Machinery Co ... 591

STEAM BLOWER FOR BURNING BREEZE.

H. E. Parson, New York City ... 594

GAS COALS.

Penn Gas Coal Co., Phila., Pa ... 609
Perkins & Co., New York City ... 608
Despard Coal Coal, Baltimore, Md ... 600
Chesapeake and Ohio R. R. Coal Agency, N. Y. City ... 600
Westmoreland Coal Company, Phila., Pa ... 600
J. & W. Wood, New York City ... 608

CANNEL COALS.

Perkins & Co., New York City ... 608
J. & W. Wood, New York City ... 608

GAS ENRICHERS.

Standard Oil Co., Cleveland, Ohio ... 609

COKE CRUSHER.

C. M. Keller, Columbus, Ind ... 608

INCLINED RETORTS.

Parker-Russell M'ning and Mfg. Co., St. Louis, Mo ... 602

RETORTS AND FIREBRICK.

J. H. Gautier & Co., Jersey City, N. J ... 602
B. Kreischer & Sons, New York City ... 602
Adam Weber, New York City ... 602
Laclede Fire Brick Mfg. Co, St. Louis, Mo ... 602
Brooklyn Retort and Fire Brick Works, Brooklyn, N. Y ... 602
Borgner & O'Brien, Phila., Pa ... 602
James Gardner, Jr., Pittsburgh, Pa ... 602
Henry Maurer & Son, New York City ... 602
Baltimore Retort and Fire Brick Co., Baltimore, Md ... 602
Parker-Russell Mining and Mfg. Co., St. Louis, Mo ... 602

COMPTOMETERS.

Felt & Tarrant Mf'g. Co., Chicago, Ills ... 591

GASHOLDER TANKS.

W. C. Whyte, New York City ... 598
J. P. Whittier, Brooklyn, N. Y ... 593

GASHOLDER PAINT.

The Government Waterproof Paint Co., Boston, Mass ... 594

CEMENTS.

C. L. Gerould & Co., Brooklyn, N. Y ... 602

SCRUBBERS AND CONDENSERS.

G. Shepard Page's Sons, New York City ... 593
R. D. Wood & Co., Phila., Pa ... 606
James R. Floyd & Sons, New York City ... 600
Continental Iron Works, Brooklyn, N. Y ... 592

REGENERATIVE FURNACES.

Bartlett, Hayward & Co., Baltimore, Md ... 605
Fred. Bredel, New York City ... 603
J. H. Gautier & Co., Jersey City, N. J ... 603
Parker-Russell Mining and Mfg. Co., St. Louis, Mo ... 602

GAS GOVERNORS.

Connelly Iron Sponge and Governor Co., New York City ... 599
Wilbraham Bros., Phila., Pa ... 599

TAR AND CARBONIC ACID EXTRACTOR.

Geo. Shepard Page's Sons, N. Y. City ... 593

COAL TAR.

J. W. Ford, Chicago, Ill ... 591

AMMONIA CONCENTRATOR.

Michigan Ammonia Works, Detroit, Mich ... 591

GAS METERS.

John J. Griffin & Co., Phila., Pa ... 610
American Meter Co., New York and Philadelphia ... 611
The Goodwin Meter Co., Philadelphia, Pa ... 612
Helme & McIlhenny, Phila., Pa ... 611
D. McDonald & Co., Albany, N. Y ... 611
Nathaniel Tufts, Boston, Mass ... 610
Maryland Meter and Manufacturing Co., Baltimore, Md ... 610
Harris Bros. & Co., Philadelphia, Pa ... 610
Keystone Meter Co., Royersford, Pa ... 611

COUPON CUTTERS.

Felt & Tarrant Mf'g. Co., Chicago, Ills ... 591

SELF-SEALING MOUTHPIECE DOORS.

Isbell-Porter Company, New York City ... 606
Continental Iron Works, Brooklyn, N. Y ... 592

BURNERS.

C. A. Gefroerer, Phila., Pa ... 601
Moses G. Wilder, Phila., Pa ... 591
Non-Corrosive Gas Tip Co., Boston, Mass ... 595

STREET LAMPS.

J. G. Miner, Morrisania, New York City ... 603
Bartlett Street Lamp Mfg. Co., New York City ... 603

PURIFYING MATERIAL.

Connelly Iron Sponge and Governor Co., New York City ... 599
Greenpoint Chemical Works, Brooklyn, N. Y ... 599
Henry W. Douglas, Ann Arbor, Mich ... 599

ELECTRICAL APPARATUS.

Wm. Henry White, N. Y. City ... 607
Fort Wayne Electric Co., Fort Wayne, Ind ... 591

EXHAUSTERS.

The P. H. & F. M. Roots Co., Connersville, Ind ... 596
Isbell-Porter Company, New York City ... 606
Wilbraham Bros., Philadelphia, Pa ... 599
Connelly Iron Sponge and Governor Co., New York City ... 599

VALVES.

Ludlow Valve Manufacturing Co., Troy, N. Y ... 601
Chapman Valve Manufacturing Co., Boston, Mass ... 601
R. D. Wood & Co., Phila., Pa ... 606
The P. H. & F. M. Roots Co., Connersville, Ind ... 560
Continental Iron Works, Brooklyn, N. Y ... 592

GAS ENGINES.

Schleicher, Schumm & Co., Phila., Pa ... 576

ENGINES AND BOILERS.

The Hazelton Boiler Co, New York City ... 593

PURIFIER SCREENS.

John Cabot, New York City ... 601

GAS STOVES.

American Meter Co., New York and Philadelphia ... 595
The Goodwin Meter Co, Phila., Pa ... 612
George M. Clark & Co., Chicago, Ills ... 593
Maryland Meter and Manufacturing Co., Baltimore, Md ... 610
The Schneider & Trenkamp Co., Cleveland, O ... 592

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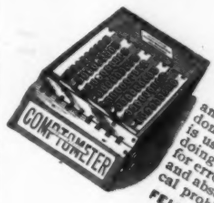

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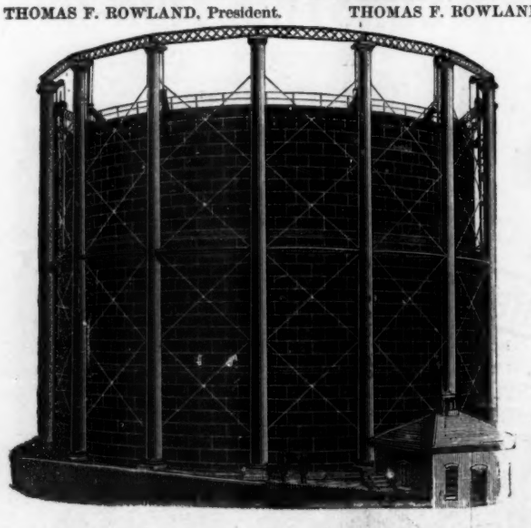

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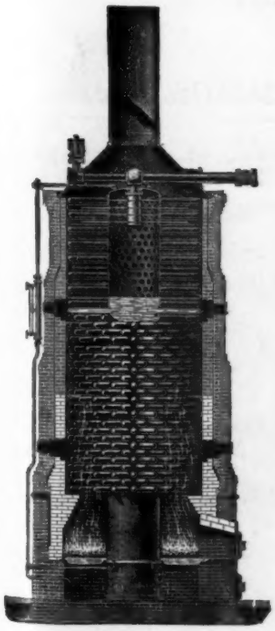

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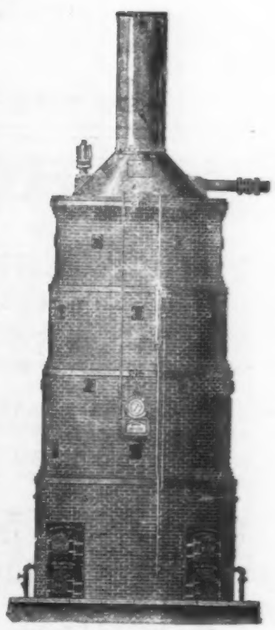

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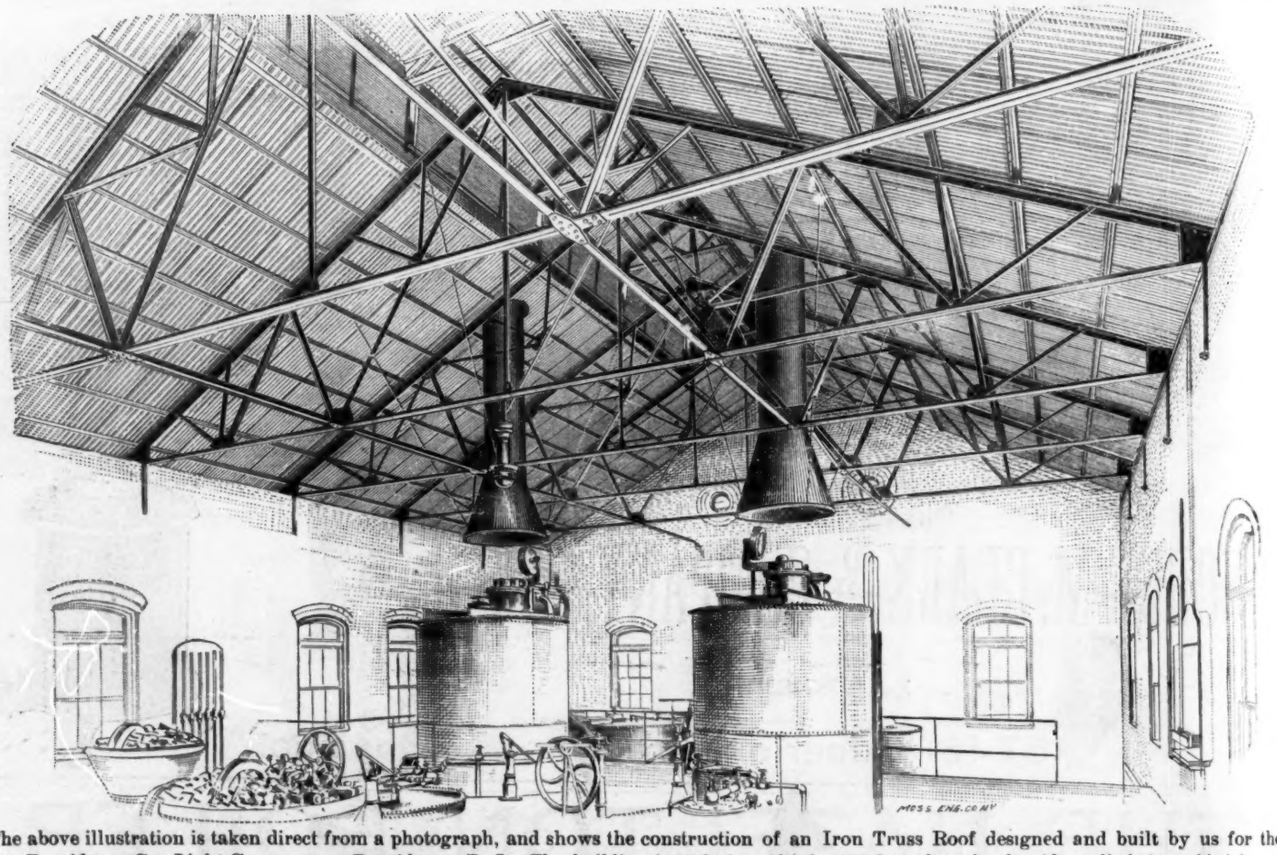

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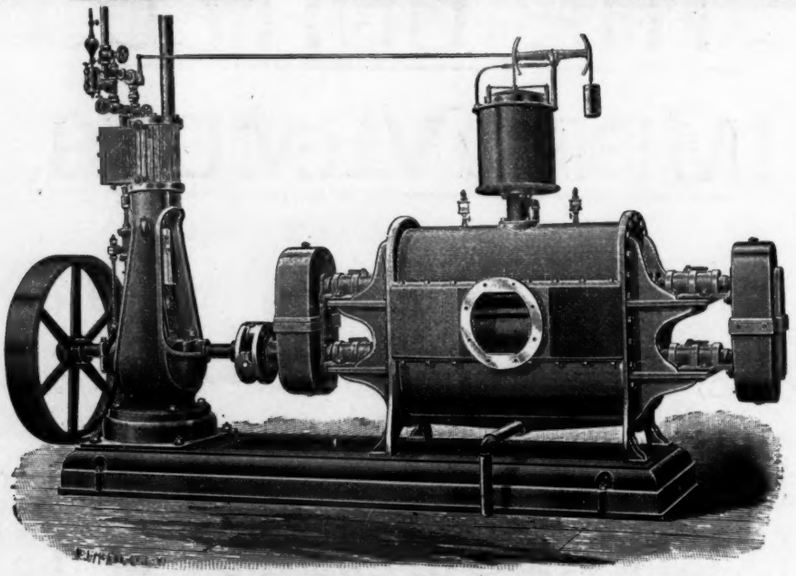

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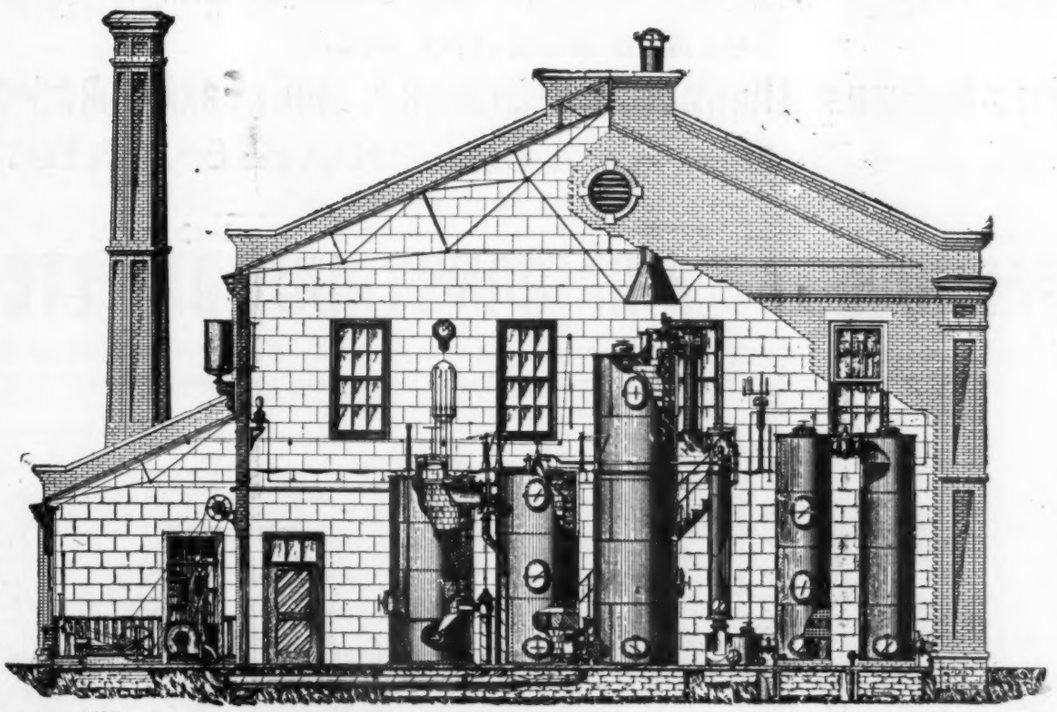

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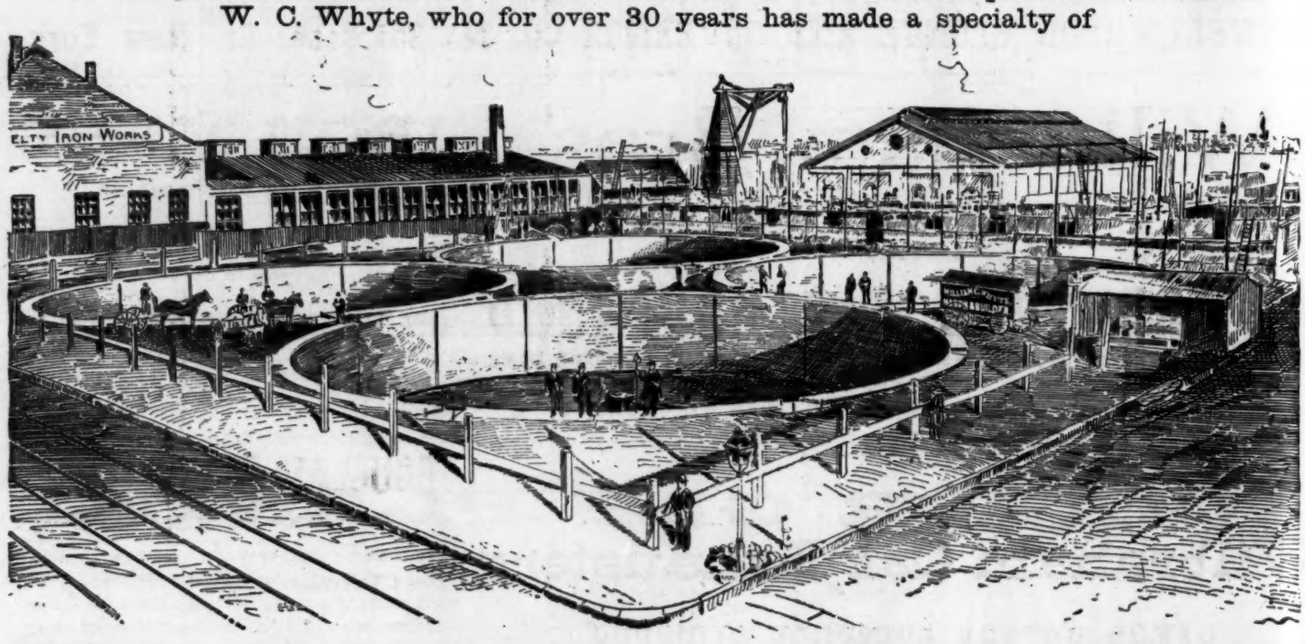

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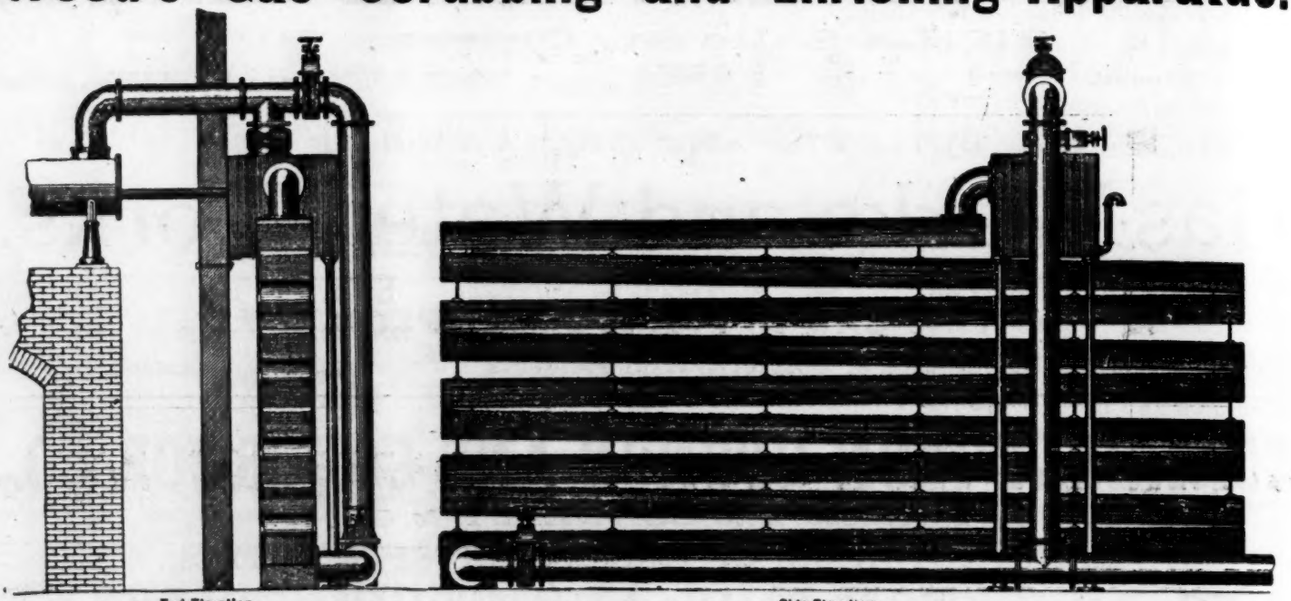

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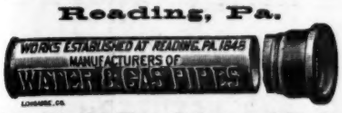

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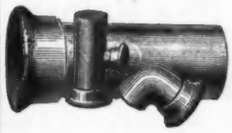

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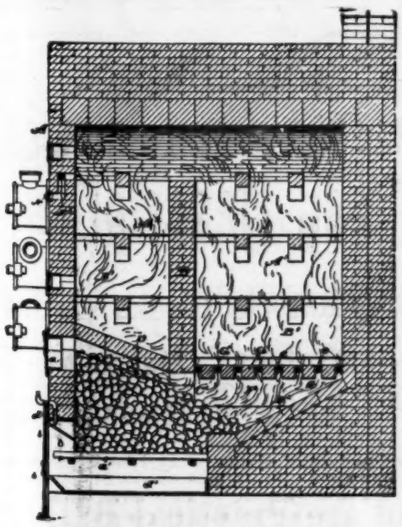

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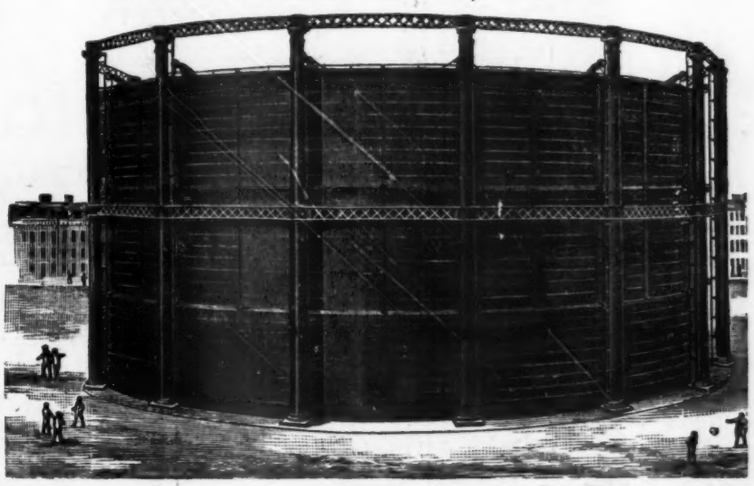

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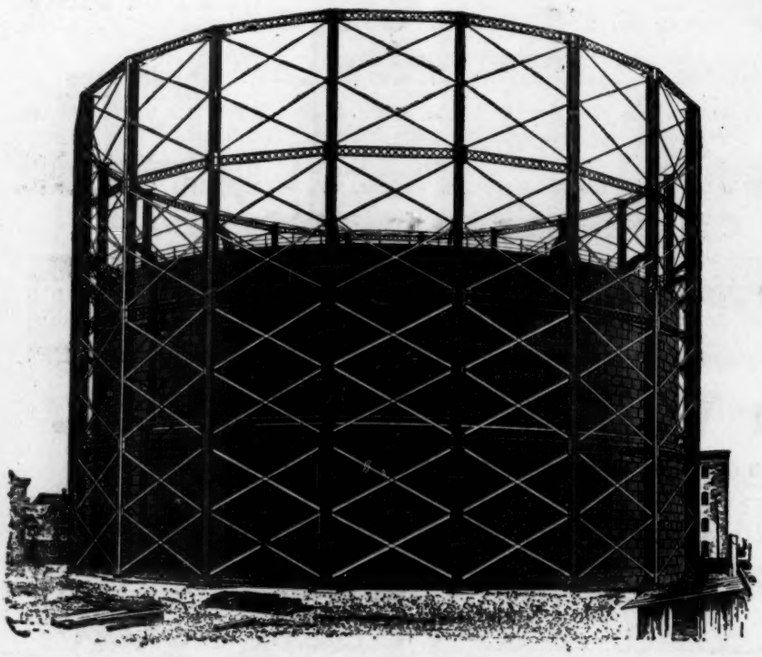

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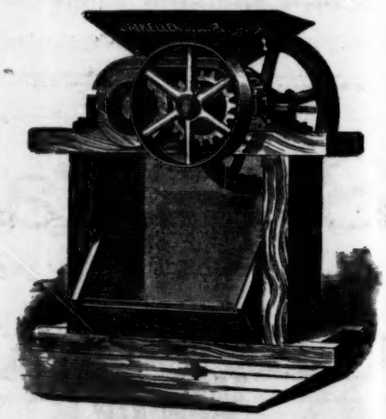

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REPAIRING.

SPECIAL.—Having purchased the sole right to manufacture and sell meters with the HEARNE IMPROVED VALVE, in the U. S., we respectfully solicit orders for the same.

The superior feature of this meter is that it avoids the danger of displacement of the valves, and consequent loss of gas, either in shipping, handling, or by dishonest consumers.

To designate from the regular Glover Meter, also made by us, we style the above the HEARNE-GLOVER Meter.

It is worth your consideration.

Full descriptive circular sent on application.

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THE GOODWIN METER CO.,

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"Sun Dial" Gas Stoves,

IN A GREAT VARIETY OF STYLES AND SIZES.

Gas Cooking Stove No. 7C.

The Most Economical, Efficient, and Durable Gas Stove Made.

SIZE.

Stove.	*Oven.*	*Broiler.*	*Top.*
31 inches high.	9¼ inches high.	10 inches high.	21 inches high.
17 inches wide.	15 inches wide.	15 inches wide.	16 inches wide.
	12⅝ inches deep.	12⅛ inches deep.	
	Length over extension shelves, 32 inches.		

This Stove has three Boiling Burners in the Top or Hot Plate, and single Oven Burner.

The consumption of this Stove is 35 cubic feet per hour, at 1½ inch pressure with all burners.

Three-eighth inch supply pipe should be used when the pressure is 1½ inches or over.

ALL FITTINGS ARE NICKEL PLATED.

Catalogue showing Styles and Prices sent free on application.

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Station Meters (square, cylindrical, or in staves), Glazed Meters, King's and Sugg's Experimental Meters, Lamp Post Meters, etc., etc.

METER PROVERS (Sizes 2, 5 and 10 feet.)

Pressure Gauges of all kinds, Pressure Registers, Pressure and Vacuum Registers, Pressure Indicators (sizes 4, 6 and 9 in.), King's Pressure & Vacuum Gauges.

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